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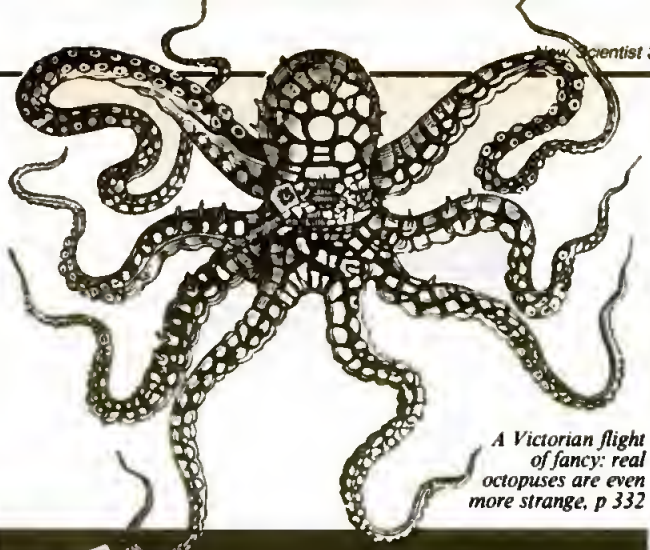
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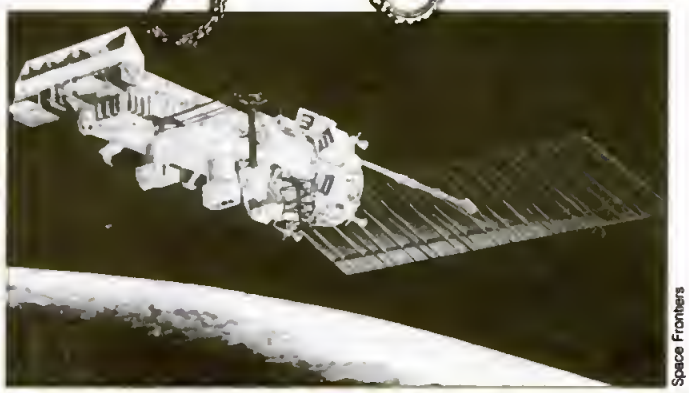
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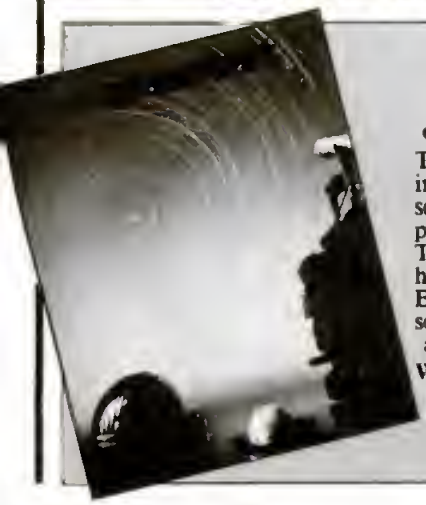
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British astronomy: out from under the clouds

This winter sees the opening of new British telescopes on top of a volcanic peak in the Canary Islands. The clarity of the skies there has enticed several other European nations to join in setting up an international astronomical observatory

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American lessons

IT IS ALWAYS tempting to see the grass as greener elsewhere, especially when elsewhere is the United States, which won a grand slam of Nobel prizes in the sciences this year. But that success surely shows us something. Of course, those who live and work in the US have their own version of distant and more verdant pastures. There they see Japan as the land of rising technology. Perhaps Arno Penzias, vice-president of research at Bell Telephone Laboratories, was right when he told *The Wall Street Journal* recently: "I don't want to say that Europeans do research purely for fun and the Japanese do it for profit, with Americans in the middle achieving the perfect balance, but there you have it."

We need look no further than Penzias himself to see one major difference between Britain and the US. Penzias is a Nobel laureate. He works for a large industrial laboratory. It is rare for British industry to have so eminent a scientist on its staff—the notable recent exception is, of course, Sir Godfrey Hounsfield, inventor of the EMI scanner—a product sadly underexploited in commercial terms.

American companies are, in general, much more likely to have a first-rate science department than their British equivalents. Here industry gives every impression of being in the hands of accountants more interested in money in the bank today than technology in the factory tomorrow. But in the US, the companies do not see their support of basic research as in conflict with their commercial ambitions. Bell, IBM, Exxon and any number of corporations, large and small, believe that they must support basic science if they are to thrive.

They do this for a number of reasons. An establishment that encourages research good enough to win Nobel prizes attracts the country's best scientists. It is, therefore, wise to invest 10 or even 20 per cent of the R&D budget in such work. And time and again today's esoteric findings are tomorrow's technology.

But companies in the US do not keep their encouragement of research to themselves. Many companies have very strong ties with universities. These links work in a number of ways. At the personal level, a company will "top up" an academic's salary so that he can continue to work in the university without being penalised. There is also a considerable flow of researchers between industry and the universities—in both directions. Rare is the academic scientist who is not involved in some way or another with a company.

Naturally, industry isn't being purely altruistic in supporting academic research. The companies see this as their way of influencing the flow and supply of scientists. A company that supports a good professor will naturally have a head start when the professor's students look around for work. And a computer company, for example, will be keen to increase the supply of computer specialists by funding a good computer department. In other words, by supporting academic research in their own areas, companies can ensure that there will be a supply of researchers for them.

In Britain, companies tend to see it as the government's job to see that the supply of scientifically qualified people matches the demand. Unfortunately, the system breaks down partly because the government has no strong "personal" stake in this—it will not go out of business if there is insufficient supply of experts in microelectronics, for example. And in any case governments have little direct control over universities in Britain. The academic community is the last place to seek knowledgeable analysis of industry's needs. Indeed, many academics in Britain, unlike their American counterparts, would rather not know about industrial needs, except when they are short of funds and want to find a soft touch.

Somehow, Britain needs to strengthen industry's links with academia, and to enhance its influence. While it would be pointless to slavishly follow the American patter, it has a lot to teach us. □

ACARD index

WITH MANY British companies reluctant to pay for research they will desperately need in the medium to long term, the government has to be extremely careful what it does with its own R&D funding, much of which is spent in industry. Under the watchful eye of Robin Nicholson, chief scientific adviser to the government, the Cabinet Office is preparing the first annual review of this spending. Already the annual review roadshow has drawn in the Science Policy Research Unit at Sussex University to do comparative studies of innovation in Britain, West Germany, Japan and the US: now the research and industry world is to have its say in the form of a 10-man study group under the auspices of ACARD, the Advisory Council for Applied Research and Development.

The study group's brief is to "survey current scientific developments and advise the council on work which shows commercial and economic promise in the medium to long term". This advice will be presumably incorporated into the policy side of annual review, which may well form part of future planning for government spending on R&D. On the face of it this is a good move, designed to incorporate the best of knowledge and viewpoints from both sides of the yawning divide between academe and industry. But it looks like a rather pathetic apology for more aggressive efforts on both sides of the fence.

Such efforts would be better organised at the level of each company, a research strategy, including input from universities and other relevant institutions, being a necessary prerequisite for any sort of government support. Government should also monitor carefully the progress and fruits of projects to see if they are undertaken in an effective way.

Meanwhile as industry comes to appreciate the value of such efforts, one might expect it to take up more of the burden of initiative and finance, as in the US. □

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THIS WEEK

Martian study predicts 'nuclear winter'

Catherine Caufield

SCIENTISTS have underestimated the consequences of a nuclear war according to a study on the golbal atmospheric effects of nuclear bombs carried out by a group of scientist headed by Carl Sagan and published this week. There would be much more radioactive fallout than has been realised previously, and even a small-scale "limited" nuclear war can cause a "nuclear winter"—the months of darkness and freezing temperatures that will follow nuclear confrontations. One hundred megatons, less than 1 per cent of the world's nuclear arsenal, would be enough to plunge the Earth into nuclear winter.

The group has built on earlier work on the effects of a global dust storm on the atmosphere and climate of Mars. It obtained data on this freak event, which occurred in late 1971, because the US's Mariner 9 spacecraft was visiting Mars at the time.

The planet's surface temperature dropped as the dust absorbed the incoming sunlight. The dust warmed the upper Martian atmosphere. After some months the dust fell out of the atmosphere and temperatures there and at ground level returned to normal. The computer models developed by the team accurately predicted the slight drops in temperature resulting from injection of dust into the Earth's atmosphere after volcanic explosions.

The team ran models for several dozen war scenarios. They varied the number and size of bombs, the time of year and distrihution of targets, and other factors crucial to the amount of dust generated in a nuclear war. Their standard case assumed a 5000 megaton war, a figure widely used elsewhere in such studies. The results, says Sagan, "astonished us".

AP

Sagan warns of Siberian winters all year round after the bomb

The team discovered a "new" source of radioactivity that previous studies have ignored. Up to now, researchers have taken account of both prompt fallout from exploding bombs and long-term fallout as radioactive particles that were carried into the stratosphere return to Earth about a year later, after most of the radioactivity has decayed. But, according to the new study, there will be serious fallout from radioactive particles that are intercepted hy the dust before they enter the stratosphere. These particles will return to Earth with much of their radioactivity intact. For the standard case roughly 30 per cent of the land northern mid latitudes could receive a radioactive dose greater than 250 rads. About half the northern midlatitudes could receive a dose greater than 100 rads. The lethal dose of radiation is 400 rads.

They also determined that after a 5000-megaton war the Earth will receive only a few per cent of its normal sunlight, too little for plants to photosynthesise. Most of the northern hemisphere, where the majority of the strategic targets for bombs are, will be frozen for months. Except for narrow coastal strips, the land temperature will drop to −25°C and stay below freezing for months, even in a summer war. Half the world will take on the climate of a deep Siberian winter. The global movement of vast quantities of heated dust would also drive tempera- tures below freezing in parts of the south-ern hemisphere, even though few bombs would fall there.

In the severe case (10 000 megatons exploded) the entire northern hemisphere will have temperatures below freezing for more than a year, and large areas of the south will have three months of freezing temperatures, followed by a longer period of severe cold (7°C). The oceans, however, will not freeze, so nuclear war will not trigger off a new ice age. But the researchers warn that because heating the upper atmosphere and cooling the lower atmosphere stabilises the atmospheric structure, they may be "seriously underestimating" how long the cold and dark will last.

The "greatest surprise", according to Sagan, came when the group considered the possiblity of a small, "contained" nuclear war. They found that exploding only 100 megatons would result in months of cold and dark almost as severe as a full-scale 5000 megaton war. □

Australia rules on fetus research

AUSTRALIA claims to be the first country to have adopted national guidelines to govern the use of tissue from the human fetus in research and tissue transplants.

The guidelines are puhlished hy the National Health and Medical Research Council. They stipulate that the fetus to be used must be the result of a spontaneous or legal abortion and it must not be capable of survival without its mother. The fetus must not have been in the womb for longer than 20 weeks and it must weigh less than 400 grams. In all cases the mother's consent for its use must be obtained.

The guidelines are the result of a detailed study by the ethics committee of the council, which includes lawyers and lay members as well as doctors and medical researchers.

The committee says that it should be illegal to buy or sell human fetuses and that dissection should not be carried out while there is any sign of life. Researchers using fetal tissue should have no contact with the mother, nor should they take part in deciding whether the fetus shows any sign of life.

The mother's separate consent should be obtained if fetal cells are to be stored, propagated in tissue culture or transplanted into another human.

Professor Dick Lovell from Melbourne University, who is the chairman of the ethics committee, said the guidelines were particularly important for Australia because of the country's strong research effort into transplanting into diabetics the islet cells in the pancreas that produce insulin.

The Australian Right to Life Association attacked the decision, saying it would institutionalise abortion and de-humanise unborn babies and their mothers. □

Weinstock wins action against *New Scientist*

LORD WEINSTOCK, managing director of Britain's GEC, was awarded £40 000 libel damages in the High Court last week over an article published in *New Scientist* in March 1981 concerning the Finniston report, which suggested improvements of the professional status of engineers.

GEC, which has an annual turnover of £600 million, was awarded £500 in damages. Mr Justice Park entered judgement against IPC Magazines, the publishers, who had denied that the article "Finniston's Wake" had implied that Lord Weinstock and GEC had wrongly sought to influence the Institution of Electrical Engineers and the government against improving engineers' status. IPC was ordered to pay costs of the nine-day hearing, unofficially estimated at £50 000.

A smiling Lord Weinstock, who had been present in court with his wife to hear the jury's verdict, commented: "Everything that has to be said has been said by the judge and jury. In the last two weeks while the case has been on I have had to spend a lot of time away from my office, now I must get back to work."

Summing up, the judge told the jury it was for them to decide the meaning to be placed on the article. It was said that the article meant that GEC and Lord Weinstock were against the implementation of the Finniston report because it would give engineers more status and therefore would have to be paid more. The jury must look carefully at the evidence to see what GEC's attitude had been.

In the witness box, Lord Weinstock had said he was in favour of any reorganisation of the engineering industry which would give engineers more status. He said that the Finniston recommendations would have "a part to play" in the engineering industry but that they would not make a critical difference. He did not believe that failure to implement the report would be a disaster for the country. The judge said: "You must bear in mind that Lord Weinstock, like any other member of the public, is entitled to express an opinion about Finniston's recommendations."

Earlier, Mr Andrew Bateson, QC, for IPC, said that Lord Weinstock had said he was "not unaccustomed" to reading disagreeable statements and in most cases just shrugged them off. But this article had been "more than the usual flea bite".

"There is no evidence at all of any injury to Lord Weinstock's feelings," he said. "These are the sort of things that normally he would shrug off "When people had the power to approach the government—not through the ballot box but by direct letters, there might be a responsibility on them to consider things not on the basis of pure company interest—such as GEC—but in the national interest," Bateson claimed.

The judge granted IPC a four week stay of execution in respect of £15 000 of the award pending a consideration of an appeal. **Press Association**

Hot-air record bid deflates

Milking the publicity earlier this year

THIS year's attempt on the world altitude record for hot-air balloons has been something of a let down. The attempt is on the verge of being postponed until next year.

The co-ordinator of Operation Sky Quest, Richard Down, said that Britain had had "the worst winds for 122 years". But he emphasised that an attempt would still be made on the world record. One option would be to look for calmer climes outside Britain but this is unlikely to attract the team, since it is sponsored by the National Dairy Council, which will want the publicity in Britain.

The record attempt has been dogged by ill-fortune. It was launched earlier this year amid high hopes. A special "Sky Qoest" cocktail (made with milk, of course) and dark hints that the secret of their success was a new burner designed for the thin air at 25 000 metres.

An attempt was scheduled in August from an RAF airfield in Norfolk. High winds forced the cancellation of this attempt, but a trial inflation of the balloon caused a seam to rip apart. But, the balloon was rapidly repaired and an attempt was announced for the week starting 29 August.

At the end of August, the team announced that Sky Quest was waiting for the weather. Then the flow of press releases came to an abrupt halt. □

Interferon may help AIDS victims

INTERFERON, the "wonder drug" with a dented reputation, may be about to gain a new lease of life in the treatment of AIDS victims. In a recent trial in the US, the condition of half of AIDS victims with Kaposi's sarcoma, the deadly skin cancer suffered by many AIDS patients, improved when they were treated with alpha-interferon. In some patients, the cancer seemed to disappear completely.

Kaposi's sarcoma can be treated quite successfully with conventional drug-therapy. But such treatment could put AIDS victims at increased risk of dying from other "opportunistic" infections. Their immune systems are already so severely depressed that normal drugs would do them more harm than good.

But preliminary results from the Memorial Sloan-Kettering Cancer Center in New York suggest that interferon may be a good alternative to conventional cytotoxic drugs. Of 12 patients put on interferon, three recovered completely from the sarcoma, and two showed some improvement. Only four deteriorated despite the interferon.

These promising results have now been confirmed by those from several other US centres, according to Dr Evan Hersh, Professor of Medicine in the Department of Clinical Immunology and Biological Therapy at the M. D. Anderson Hospital and Tumor Institute in Houston, Texas. However, only patients whose immune systems are still working—albeit below par—appear to benefit. Many have immune systems too depressed to respond.

But, Hersh suggested at a cancer symposium in Venice recently, interferon could be used to treat AIDS victims *before* their immune systems become very depressed and before they have a chance to develop Kaposi's sarcoma.

The big question, of course, is can interferon be used to treat AIDS as well as the sarcoma that results from it? Dr Tony Pinching, senior lecturer in clinical immunology at St Mary's Hospital, London, is not optimistic. He says that treating Kaposi's sarcomma is one thing, curing AIDS quite another. "Kaposi's sarcoma is the most benign end of the AIDS spectrum. They are the ones who are the best preserved immunologically." In such patients, interferon is "stimulating what remains rather than something which has gone away altogether".

People with AIDS have two problems. One is they have many fewer than normal T-helper cells—which "help" the body produce antibodies. The other is that their natural killer cells are feeble. Interferon's main action seems to be to stimulate these natural killers. This explains why it may help in Kaposi's sarcoma. On the other hand, if AIDS is caused by a virus, it is one which has already proved itself quite capable of by-passing the body's natural killer-cell force. If it could not do this, the killers would have sent it packing before AIDS could develop. □

Leukaemia deaths linked to Sellafield

A BRITISH television company this week claimed to have uncovered new evidence of high rates of leukaemia among young children in the villages around the nuclear reprocessing plant at Sellafield (formerly Windscale) in Cumbria.

Nadeen Chedd

Cumbrian mudflats that harbour plutonium

Several months of doorstep inquiries by researchers from Yorkshire Television revealed five deaths from leukaemia in the past 30 years among children under 10 at the village of Seascale, 2 kilometres from the complex. The expected figure, based on national statistics, would be 0.45 deaths, according to John Urquhart, a statistician from the University of Newcastle-upon-Tyne. Urquhart was a consultant for the programme, *Windscale—The Nuclear Laundry,* which was broadcast on Tuesday evening.

In a follow-up study, which included the villages of Waberthwaite and Bootle, immediately south of Seascale, the researchers found 14 cases of cancer among children under 18 in the same period. National figures would have predicted three cases. Ten of the cases were in Seascale.

The high incidence apparently did not show up in local health statistics because the smallest administrative unit used was the former rural district of Millom, for which cancer death rates are, overall only slightly higher than expected.

Urquhart claims that there is some evidence of a cluster of deaths soon after a fire at Windscale in 1957, which spread isotopes of iodine and polonium over the surrounding area, and a hint that the rates may have increased again in recent years. But the total numbers involved are too small to be certain. Three cases of cancer of the testicles among small boys were also discovered in the villages.

The television programme linked the cluster of cancer cases to discharges into the Irish Sea via a pipeline from the Sellafield reprocessing plant. It produced the first evidence that tiny amounts of plutonium from the plant have turned up in household dust. The contents of a vacuum cleaner from a house in Ravenglass, a village 9 km from Sellafield, were found to contain plutonium along with americium, caesium and ruthenium—all of which are discharged from the pipeline.

There has been concern for a number of years that these materials, which are known to be absorbed onto silt in the Ravenglass estuary, might be blown back onto land whenever the silt dries out. Plutonium is particularly dangerous. If inhaled it can cause lung cancer.

The issue was raised at the public inquiry in 1977 into plans for a new reprocessing plant at Sellafield. Since then, the National Radiological Protection Board (NRPB) has monitored the air in the Ravenglass area. But household dust has not been monitored, even though indoor dust is known to accumulate other harmful substances present in the atmosphere, such as lead. Dust in the Ravenglass vacuum cleaner contained 6·7 pico-curies of plutonium-239 and 5·1 pCi of americium-241.

British Nuclear Fuels, which runs the reprocessing plant, announced recently that discharges from the pipeline were to be cut. This followed a conclusion by the NRPB that the uptake of plutonium in the gut was probably five times higher than previously assumed *(New Scientist*, 13 October, p 73).

That report also warns that, in the first year of life, the guts of babies may absorb 10 times more plutonium than the gut of an adult. □

Nuclear scientist makes his peace

DR ROSS HESKETH, the nuclear scientist at the centre of a row over what happens to British plutonium, has been reinstated by his former employer, the Central Electricity Generating Board (CEGB). The deal was agreed by Hesketh's union, the Electrical Power Engineers Association.

The change of heart by the CEGB came just days before Hesketh was due to refer his earlier sacking by the board to an industrial tribunal. Hesketh's dismissal was ostensibly because of his refusal to be redeployed at the Berkeley R&D centre in Gloucestershire. But he always maintained that he was disciplined because of his criticism of the efficacy of existing international safeguards for the use for nuclear armaments of plutonium from the civil nuclear programme.

Under the arrangements agreed between the parties, Hesketh is back in post from this week. But he will take sabbatical leave until July next year when he becomes eligible for early retirement. By this device Hesketh's pension rights are safeguarded. Neither the scientist nor the board is making a public statement on the case.

The engineers' association, which never accepted that Hesketh was sacked for being a critic, said last week that it had taken up the scientist's case for "humanitarian" reasons. However, the union is taking seriously the question of whether international safeguards over plutonium proliferation are sufficiently stringent. An internal union working party is looking at existing treaties and will be reporting to next April's annual delegate conference with proposals to stiffen the safeguards. □

ACARD seeks trump cards

THE GREAT conundrum of British R&D—how to pick the commercial winners and ensure that they obtain proper financial backing—is to be addressed by a new study group set up by the Advisory Council for Applied Research and Development (ACARD).

Dr Charles Reece, the director nf research and technology at ICI, will lead the 10-man study group, which will also include Professor Sir Hermann Bondi, Cyril Hilsum, chief scientist at GEC's Hirst Research Centre, Professor Gareth Roberts of Durham University, and Professor John Thomas nf the University nf Cambridge.

The group's deliberations should also provide some input for the government's Annual Review of Research—a run-dnwn nf hnw much the government spends nn research. The first of these annual reviews is now in preparation.

Reece, an organic chemist and a member of ACARD, said that the study would take two to three months. It was already his job to review scientific developments for ICI; now he would be dning it fnr the country as well.

A separate wnrking group will study developments in control and instrumentation technnlogy, and the manufacture and use of control systems in Britain. The chairman of the eight-man group will be Dr Brian Lindley, directnr of technology fnr Dunlnp Hnldings. Amnng their subjects, the group will try to determine what measures are needed to ensure that new and existing technology is used in industry and widely exploited. □

Hypers outlawed

THE BRITISH record industry has decided to stamp out a computerised method of "hyping" records into the best-seller pop music charts.

One extraordinary dodge was revealed in *New Scientist* (8 September, p 670). Record companies sent representatives to identify those few hundred record shops that displayed on their counters the computer terminals linking them to the Gallup market research company, which compiles the charts. Then they offered video cassettes worth at least £5 to anybody who bought the pop single being "hyped" at one of those shops. Result: the record hits the charts, radio plays proliferate and sales boom.

But, starting from this week, Gallup and the British Phnnograph Industry (BPI) have ruled that all records sold with a free gift will be ignored when the charts are compiled.

The BPI is also to act against less subtle hype. It has fined Arista Records £3000 after a promntinn representative selling the company's records was caught helping a chart shop to make false entries on its terminal. □

Mitsubishi spying plea

LAST year's highly publicised industrial espionage cases in California's Silicon Valley, invnlving the alleged theft nf IBM trade secrets by employees of two Japanese companies, Hitachi and Mitsubishi, are finally over.

The case against Hitachi was settled last month (*New Scientist*, 13 October, p 77). And, in San Francisco late last mnnth, Mitsubishi pleaded no contest while two of its emplnyees pleaded guilty to charges nf conspiring to transport stolen documents from IBM to Japan.

The firm and the employees—Kazuma Ban and Takaya Ishida—were each fined $10 000. Two other emplnyees whn have remained in Japan will have charges against them dropped within a year if they dn nnt conduct any business within the US. In a "sting" operation by the FBI, Mitsubishi allegedly paid undercover agents $26 000 for material represented as stolen from IBM. □

CB freaks turn on, tune in and blow themselves up

Barry Fox

THOUSANDS of users of citizens' band radios in Britain may this week attempt to swindle petrol stations by using high-powered transmitters to confuse electronic pumps and to drive off with cbeap petrol. But the dodge, revealed in the British press last weekend, is, quite literally, lethal.

Amateur radio "hams", wbo often despise CB freaks for their clumsy use of tbe airwaves, have long been aware that a high-power radio transmitter can upset the electronics in a petrol pump. But they also know that it could trigger an explosion. This is why drivers with high-power transmitters in their cars switcb them off when they are on the forecourt of a garage. High-energy radio waves can create a spark in metal objects that triggers an explosion. Explosive experts are well aware of the pbenomenon, and the army even exploits it in Northern Ireland.

Licensed radio "hams" can legally install 100-watt FM amplifiers in their cars for long-distance two-way communication on the move. CB enthusiasts are legally limited to a few watts. But they often install equally powerful amplifiers or "after burners" to boost their transmitted signal. This way they can blot out others trying to use the same frequency. The situation is now so bad in Britain that in most major cities sensible CB communication is impossible.

Any high-power radio transmitter can upset electronic equipment, especially if it includes integrated-circuit chips and microprocessors. The radiation causes logic gates to open when they should close and makes synchronising circuits run at the wrong speed.

Professional electronic equipment has built-in shielding to block unwanted radiation. But domestic equipment, and until now petrol pumps, has not been shielded. So bigh-power radiation from a nearby transmitter can easily make the electronics go haywire. Whether the petrol meter runs fast or slow may be a matter of chance, however.

In the US, CB freaks bave found tbat they can upset electronic breathalysers. Tbe only problem is that they cannot be sure that they will score an artificially low reading. Conjurers use a similar technique to upset watcbes without touching them.

The biggest risk for pump fiddlers is an explosion. Any metal rod which has a length that is a simple fraction of the transmitted wavelength can act as an aerial and generate an electronic signal. If the transmitter power is high and the range short, the signal may be strong enough to cause a spark. This can ignite petrol or detonate an explosive.

When contractors had to blast in Central Park in New York recently, they put up notices warning everyone to switch off tbeir CB transmitters. But the explosive handlers were worried in case this merely encouraged some people to transmit at full strength and listen for bangs.

Tbe Britisb army in Belfast has for many years driven trucks with high-power, wide-band transmitters, broadcasting random frequencies at full blast. Anyone mixing an unstable bome-made bomb, or planting it, is likely to disappear in a puff of smoke. This is also wby the IBA is moving one of its medium-wave commercial radio transmitters away from an oil refinery in the north of Scotland. The sound of pop music could have set the oil on fire. □

Bedfordshire brickfields: Britain's favourite dump

LAST WEEK the Bedfordshire brickfields were earmarked for use as a burial ground for radioactive waste. This week a report recommends their use to take millions of tonnes of spoil from a coal mine that is set to open in 1985. A government working party told the Department of the Environment that it should investigate European Community funding to pay for carrying spoil from the new coal mine in Leicestershire, on the edge of the Vale of Belvoir.

The pit will produce 2 million tonnes of spoil each year. Sites shortlisted for its disposal are limestone workings at Ketton in Leicestershire, and brickfields at Peterborough and Marston Vale south of Bedford.

A typical scheme would add £1·05 to the cost of a tonne of coal, says the working party. The National Coal Board says it cannot afford it—hence the call for a European subsidy to protect the environment of Leicestershire from huge new spoil heaps.

Another solution could be "back-stowing" the waste into the mines themselves. But a second working party last week reported to the government that this would increase the cost of coal from Leicestershire by £4·29. □

Unreal experiences of the Real World

THIS MAN has volunteered for an experiment that involved him floating in a tank of water at blood beat for 12 hours. "White noise" was fed into bis ears and his mask covered with a translucent material to provide a constant, blank, visual field. At the end of this period of sensory deprivation, he was given a series of mental aptitude tests to see what effect, if any, long periods of empty solitude has on the buman condition.

TVS

Taking a dive for the television cameras

The experiment was part of a television programme called *To Boldly Go*, which was broadcast by Television South this week. It is one in a series called *The Real World*. The volunteer, Jobn Leecb, is an experienced commercial diver. He was given tests before and after his 12-hour stretch in an 18-tonne tank of water. The tests included logical reasoning, semantic processing (fish and chips are male; true or false), mental arithmetic, and a questionnaire asking him about his mood. He was also asked at random points during the experiment to estimate the time spent in the tank.

He started out with scores close to a 100 per cent. After 12 hours, these fell by only 2 per cent, but the time taken to finish was up to 46 per cent longer. He consistently underestimated the time that he had spent in the tank. After 2·75 hours, his estimate was 1·5 bours, after 5·5 bours it was 4·5 hours, and by 7 hours, be gave up trying to estimate at all.

Leach said that after the test he felt more clumsy, drowsy and dreamy, and more mentally slow, incompetent, antagonistic and withdrawn. He also reported a minor hallucination; at one stage he thought be saw his mask beginning to cave in. □

No *esprit de corps* in Luxembourg

ESPRIT, the European Community's pioneering researcb programme in information technology has still not been given the go ahead. A meeting of the Council of Researcb Ministers in Luxembourg last week argued loud and long about the size and distribution of the proposed £1 billion budget for Esprit. But, as the bars in the city began to close, they gave up without reaching agreement.

The EEC's Commissioner for Science, Etienne Davignon, claimed that the ministers bad not done their homework on papers presented by the Commission. But delegates said that a last-minute letter from Davignon, designed to persuade them to agree a programme, was to blame.

The chaos over Esprit threw other items on the agenda into abeyance. This included the four-year Joint Research Centre programme. □

Where the gentry take pot shots at an endangered species

Catherine Caufield

ANYBODY with £50 to spare and an invitation from Lord Margadale in his pocket can spend a day this winter shooting one of the world's most endangered species of birds, the barnacle goose, on the Scottisb island of Islay. The island is the winter bome for a fifth of the world population of the geese and, in tbeory, the birds are protected under British and European law. But Lord Margadale's money-spinning shooting parties, whicb last year netted him around £10 000, are sanctioned by the Scottish Office "to prevent serious damage to crops".

Islay is an almost feudal community. Most of the island's 60 000 hectares are divided up among a handful of large estates. The largest is the Islay Estate, which is owned by Lord Margadale, who, in earlier years was John Granville Morrison, the Conservative MP for Salisbury. Two of the Lord's sons are now MPs and one, Peter, is a junior minister at the Department of Employment. Margaret Thatcher and Peter's former boss at the department, Norman Tebbit, are among the public figures known to have visited the island.

"Britain is the only place in the world where you can pay to shoot these geese," says Peter Ellis of the Royal Society for the Protection of Birds (RSPB). The Scottish Office issues licences for the shoots under the Wildlife and Countryside Act 1981. Tbat law brought Britain into line with the European Community's Directive on the Conservation of Wild Birds. It banned the hunting of barnacle geese and guaranteed that "special measures" would be taken to protect the species. But it also allowed the geese to be shot under licence "to prevent serious damage to crops". Yet last winter the department issued licences—not to tenant farmers, but to the estate owners.

Gordon Langsbury/Bruce Coleman

Barnacle geese: unfair game

The owners then passed the shooting rights on—not to their farmers, whose crops the licences were issued to protect, but to well-heeled shooting parties.

The National Farmers Union says that shooting for sport is an ineffective method of controlling birds that damage. It says tbat its members on Islay have suffered financial losses as a result of not having their own licences.

The Nature Conservancy Council and the RSPB say that the licences are frequently violated to make the shooting more "sporting". Geese that are feeding harmlessly on salt marsbes are flushed out to be shot by hidden guns, for instance. But David Boyd, the factor of the Islay Estate, says that the sbooting requires time and skills that the farmers do not possess. "We're doing them a very considerable service and they recognise it," he said.

The Scottish Office is obliged to consult the Nature Conservancy Council before issuing licences to kill a protected species. But it has disregarded the council's advice that, on 38 of the 53 farms covered by licences, crops could be protected by less drastic action, sucb as scaring. The officials also ignored the council's objections by issuing licences for two Sites of Special Scientific Interest that were established specifically to protect barnacle geese.

After last winter's shoot the Scottish Office tried to accomodate the complaints of farmers and conservationists. In August it circulated revised proposals for licensing, whicb included a rule that the farmers, not the estate owners, should be given the licences.

But Lord Margadale and his fellow lairds objected. And in mid-September most of the reforms were revoked. Farmers may now apply for licences along with landlords. However, a farmer's licence allows only one person to sboot and, says the Scottish Office, the tenant "will still wbere necessary have to obtain permission to shoot from his landlord". The landlord can still send out his shooting parties to continue their sport.

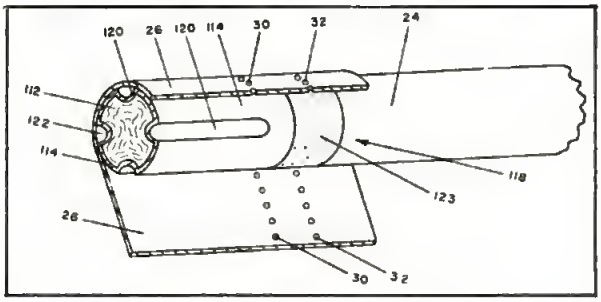
During the stormy passage of the 1981 act through the British parliament, Margadale made it clear that he would support the government only "provided the traditional sports of the countryside will be protected". □

Patents filed for filter that 'cheats'

PATENT applications filed in London have brought a new twist to the saga of the "Actron" cigarette filter, which allegedly "cheats" official smoking machines to gain an undeservedly low tar rating for the cigarette on the end of the filter. The patent applications are from Brown and Williamson, the company whicb has pioneered the "Actron" filter on its "Barclay" cigarettes. They reveal that the company is well aware that smokers may crush special grooves in the filter with their fingers and so increase their intake of tar from the cigarette. The company nonetheless denies that this bappens in practice.

The British applications, numbers 2 117 218, 2 117 219 and 2 117 221, were published three weeks ago. They follow similar applications made in the US in February and Marcb 1982.

One patent (2 117 219) describes the basic design—a filter tip with four longitudinal grooves covered by a perforated wrapper. Fresh air is sucked in through the perforations, travels along the grooves and mixes with the smoke flowing through the filter, to dilute it.



Patent 2 117 219: key features of the "Actron" filter

Another patent (2 117 221) suggests the idea of recessing the ends of the grooves into the filter body.

The third application (2 117 218) takes up the crucial problem of what happens when the grooves get blocked.

Neil Akkerman and Gonzalo Vazquez, the inventors, suggest a dozen different solutions. But they all have the same basic idea in common. Air can escape from the grooves into the filter body. It does this through tiny boles, slits or porous sections in the groove walls.

If the grooves become blocked, as may happen when a cigarette is beld between the smoker's fingers, air is sucked into the filter body from part-way along the grooves, where it mingles with the smoke. But bere a problem arises. What is to stop the smoke escaping out of the grooves, from part-way along the filter, and then being sucked straight into the smoker's mouth without full filtering? The Brown and Williamson patent has an answer for this.

"It has been determined that a porous region spaced from approximately 2 mm to approximately 4 mm from the mouth end of the filter, and covering an area of approximately 0·2 mm^2, works well to provide a flow path for ventilating air from the grooves into the filter rod under certain smoking conditions, while preventing the flow of significant amounts of smoke from the filter rod into the grooves under otber smoking conditions." Although the patent refers several times to "certain smoking conditions" these are never defined.

The patent applications suggest plans have been made for a launch in Britain. The launch may be of "Barclay"—a cigarette sold in the US, Europe and Australia, that has the "Actron" filter. □

Japanese solve riddle of salmon—cloning

Bob Johnstone, Tokyo

JAPANESE scientists have turned an abandoned British technique for cloning salmon into what could be a commercial money-spinner, bringing more and cheaper salmon to the dinner tables of the world. Professor Hiroshi Onosato of Hokkaido University's Faculty of Fisheries will present his findings at an international conference at Seattle in the US later this month. He will claim that the technique could be adapted to all kinds of livestock.

Current methods of stocking salmon are wasteful. Males and females are produced in equal numbers yet, for breeding, one male is sufficient to fertilise the eggs of 30 to 40 females. Moreover, the flesh of the male salmon becomes unpalatable during the mating season so, when caught, such fish can only be used as animal feed.

Onosato and his cloned salmon

Salmon are also ideal for cloning. They produce vast quantities of large, easy-to-handle eggs which are fertilised outside the body. The cloning technique hinges on two processes: the destruction of the sex-determining chromosomes of either the sperm or the egg, and the inhibition of the production of the polar body. This is the mechanism that the cell nucleus uses to get rid of its unwanted extra set of chromosomes, which then becomes the sex determinant for the fertilised egg.

To produce female fish, Professor Onosato brought together untreated eggs and sperms that had been exposed to gamma rays, which destroy the male genes. The sperm still stimulate the eggs to complete division, and so allow fertilisation to occur. Then Onosato treated the egg-culture fluid with a pressure of 700 atmospheres for several minutes to prevent the production of polar bodies.

The British researchers who pioneered this work at the Ministry of Agriculture, Fisheries and Food's fisheries laboratory in Lowestoft used low temperatures rather than high pressure to achieve the same end. The Japanese claim their method is more efficient, producing 60 per cent hatch rate within 69 days; all fry were females, 90 per cent of them identical to the mother from whom they had received all their chromosomes.

The production of males is trickier. This time the sperm is left untreated and the egg is irradiated to destroy its genes. Fertilisation is allowed to take place, then high pressures and temperatures are used to prevent normal division, so that the nucleus does not divide but the number of chromosomes doubles.

Since sperms have both X- and Y-chromosomes, the resultant offspring are half "normal" XX females and half "super" YY males. The mating of normal eggs with super-male sperm results in all XY-male offspring. The snag is that the male hatching rate of super-males is very low—only about 50 to 60 per 10 000. So Onosato has tried changing the sex of female fish. Immediately after birth, female fry are immersed in a solution of male hormone. Eighty per cent become able to function as males, while still being chromosomally female.

Other Japanese scientists have been applying Onosato's methods to breeding mice with some success. In theory the procedure can be applied to any animal whose eggs can be fertilised externally. □

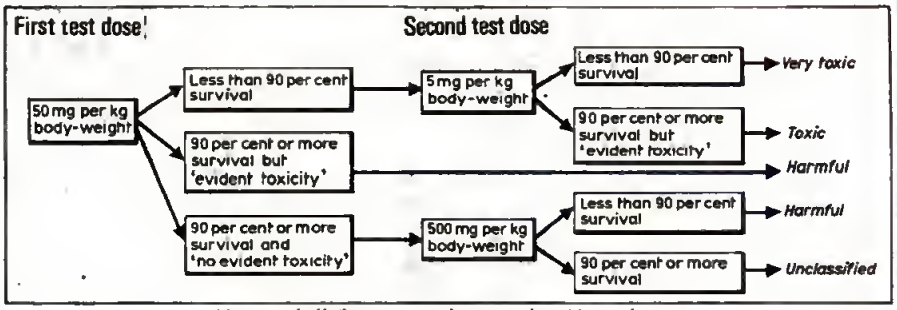
New toxicity test could cut laboratory deaths

THE CARNAGE of dead and mutilated animals in toxicology laboratories could be significantly reduced if researchers would end their blind allegiance to the LD_{50} test, in which 50 per cent of a sample of animals have to die to prove a substance's toxicity. Toxicologists at a conference in London last week heard of a new practical method of testing on live animals that retains most of the advantages of the LD_{50}, but reduces the death rate. It was presented by Michael van den Heuvel from the British Toxicologist Society.

Millions of laboratory rats die every year in LD_{50} tests that are designed to assess the risk to human health from new products and chemical compounds. But large discrepancies in results between laboratories are common, and toxicologists are looking for better methods of testing. This would both produce better science and reduce the massive suffering and death among animals.

Other methods, such as cell culture tests, that use no animals often fail to meet the requirements of a true alternative to the LD_{50} test. This not only provides information on the lethal dose of a substance, but also on its effect on body tissue, the time of death after dosing and other useful information.

The LD_{50} test is increasingly used as a basis of an international toxicity classification system. This categorises substances as harmful if the LD_{50} for an oral dose is around 500 miligrams per kilogram body-weight; toxic if the LD_{50} is 50 mg and very toxic if it is 5 mg.



How to kill fewer rats the van den Heuvel way

The van den Heuvel approach provides as much information as the LD_{50} test and allows a comparable classification of the substances to the LD_{50} test. Van den Heuvel says that it should also provide results that are more accurate and more reproducible. The toxicologist starts the study of a new material with a dose of 50 mg/kg fed to rats. As soon as more than 10 per cent of the rats die the researcher can stop the test and save the surviving animals. A retest with a dose of 5 mg/kg allows classification between "very toxic" and "toxic" (see diagram).

Instead of perhaps 30 animals being involved in a typical test, with at least 15 animals dead at the end of it, the new test needs perhaps half as many animals, with most of them surviving.

One serious drawback is that the toxicologist has to determine by his own observation whether animals are suffering —that is whether there is "evident toxicity".

Van den Heuvel argues that if a researcher underestimates the evident toxicity a substance at the 50 mg/kg level, he has to retest the substance at the 500 mg/kg level. So the system is self-adjusting.

Van den Heuvel's team has reconstructed from LD_{50} data how 153 chemical compounds would have been classified if they were tested under the new scheme. Eighty per cent of the chemicals fitted the same category, 15 per cent would have been classified as less toxic and 5 per cent more toxic. □

Business through the wrong end of a telescope

BRITAIN'S leading manufacturer of telescopes, Grubb-Parsons, is to close. Its owner, the turbine company NEI-Parsons, will convert the telescope factory in Newcastle-upon-Tyne into a factory for making metal pipes.

The firm has been turning out some of the world's leading telescopes for more than a century, since it was founded by the father-and-son team of Thomas and Howard Grubb in Dublin. In recent years, Grubb-Parsons has been building the three British telescopes for the new observatory on La Palma in the Canary Islands. It has already converted the 2·5-metre Isaac Newton telescope, which was originally built by the firm in the 1960s, and has built a new one-metre telescope. Now it is in the final stages of constructing the giant William Herschel telescope, a 4·2-metre reflector which will be the world's third-largest telescope.

NEI-Parsons

A final polish for the mirror on the William Herschel telescope

The major loss to astronomers will be Grubb-Parsons' expertise in grinding the accurate mirrors needed in large telescopes. As well as the huge mirror for the William Herschel telescope, the firm has "figured" the mirrors for the 3·9-metre Anglo-Australian telescope and the 3·8-metre infrared telescope, UKIRT.

Their expertise has enabled Grubb-Parsons to undertake projects such as building a large, thin lens composed of two sheets of glass that was installed as a corrector-plate for the British Schmidt telescope in Australia. That was something never attempted before by an optical firm.

But telescope-making is only a small part of the overall NEI-Parsons operation, employing 90 people out of a total workforce of 4500. A spokesman for NEI-Parsons said that the future market for telescopes is uncertain, and there is no immediate prospect for another major telescope after the William Herschel.

A recent excursion into small telescopes for amateur astronomers did not pay off for Grubb-Parsons. The Astronomer Royal, Graham Smith, who worked closely with Grubb-Parsons on the La Palma telescopes, told *New Scientist*: "It is sad, but the writing has been on the wall for some time. When we want large telescopes in future we will have to go overseas. As well as meaning more money spent abroad, we shall not have the extremely useful close collaboration between the optical experts in the observatories and the mirror maker." □

Dawn of the biological computer is delayed

Ian Anderson, Los Angeles

FUTURISTS who envisage a new breed of computer with molecules and proteins for circuitry rather than silicon chips are in for a long wait, according to a unique scientific gathering held in Los Angeles last week. Some scientists have speculated that the so-called molecular computer which would mimic functions of the human brain, such as memory and reasoning, is within reach.

But last week's gathering of 35 scientists from four disciplines poured cold water on the idea—at least in the forseeable future. "The outcome was very conservative," the conference organiser, Dr F. Eugene Yates from UCLA's Crump Institute for medical engineering said. "They were sceptical about claims that biochips were here, or just around the corner."

The scientists were chosen because of their expertise in at least one of four areas, computer science, chemistry, physics, and biology—and because they had no financial stake in the new technology. Their brief was to evaluate the feasibility of carbon-based molecular computers and to prepare a report for the National Science Foundation (NSF), which is said to be in a dilemma over whether or not to fund the growing number of proposals related to biochips. All but two were American scientists.

The report is now being drafted and it is expected to be sent to the NSF by the end of the year. It is clear from last week's closing session that it will recommend that the molecular computer should be regarded as needing basic research. It is not ready for applied research.

"The conference at best will reorient the policy makers away from fadishness about the computer revolution to a more sober assessment of where investment should be placed," Yates said. "What they should not do is make a sudden injection of money into a non-entity—the biochip." Both NSF and the US Department of Defense had representatives at the conference.

But the British representative, Frank Pettit, a computer expert and author who recently retired from the Computing Teaching Centre at Oxford was concerned that the message from the conference should not be too negative. "We musn't put people off," he said.

Practicable limitations needing much basic research, not theoretical ones, were cited as the main stumbling block. In theory, a molecular computer should work. The idea would be to use a protein such as an enzyme in a three-dimensional configuration so that the machine would have the properties of the molecule and be able to recognise, handle and transmit information in a more sophisticated way than the two-state "on-off" switches of the digital computer.

It would have its own intelligence and be able to recognise patterns and objects and make decisions and associations. The molecule could be genetically engineered for the purpose.

But the hurdles involving construction and fabrication are formidable. How do you, for instance, connect the molecular switches into a functioning network? Another problem is stability of the molecules. They tend to self-destruct and so the molecular switches would have to be increased in size to make them more stable, negating any size advantage over conventional silicon circuitry. It is not known how to imitate biological systems and "replace" parts. Another difficulty is that the charge characteristics of organic semiconductors are not well understood. Impurities are another potential problem.

A model system based on the theoretical existence of a continual energy wave called a soliton was presented by Forrest Carter from the Naval Research Laboratory in Washington. The wave would act much like a collapsing stack of dominos or cards placed end on. No energy would be dissipated, but chemists at the conference doubted that it could be made reversible, a necessary requirement for a circuit. Pettit termed the model "very impressive" and said that scientists should investigate it further.

But the conference also indicated that demand for a molecular computer, especially from the non-military sector, was way in the future. The technology spin-off from the huge investment the Japanese, Americans, and Europeans are making into the fifth generation or supercomputer would probably meet computing needs for at least two decades. "Come back in ten years and I'll bet the bio-computer will be a hot item," said Yates.

However, the conference strongly supported the development of bio-sensors, sensory devices based on protein that would recognise patterns. These could be linked to computers which would provide the analysis.

Experiments with this technology could help solve some of the problems regarding the molecular computer. □

Nuclear weapons are no defence

Cruise missiles were due to arrive in England by Christmas. But many military strategists argue that nuclear weapons do not strengthen our defences

Mike Pentz

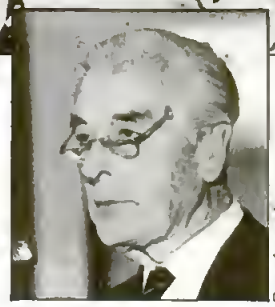
Keystone

Life in Nagasaki, September 1945, in the aftermath of the atomic bomb

THE ADMIRAL of the Fleet, Earl Mountbatten, in his now famous speech in Strasbourg on 11 May, 1979, warned that the nuclear arms race has no military purpose. Almost exactly two years later, a very similar view was expressed by a senior American statesman, George Kennan. The latest of many eminent scientific, military and political authorities to have reached a similar conclusion is Robert McNamara, who was one of the principal architects of NATO's nuclear defence strategy based on "flexible response".

It is high time that serious attention is given to these and similar statements, and to the reasoning on which they are based, for if they are not mere rhetoric they have profound implications. If nuclear weapons are, in fact, "useless", and if the idea that their possession can contribute to our defence is a "dangerous illusion", then the argument that if we were to get rid of them we would be left "defenceless" simply collapses. If nuclear weapons really are no use for defence, then our reliance upon an illusory defence strategy must actually *weaken* our real defence capability.

In most people's minds, the only significant threat against which we need to defend ourselves is that of Soviet aggression. In its extreme form, this threat is visualised in terms of a massive conventional attack upon Western Europe, spearheaded by those 27 000 Soviet tanks, culminating in a sea-borne and air-borne invasion of the United Kingdom. Setting aside the political credibility of this threat, it is clear that, if the worst came to the worst and the 20 000 or so precision guided anti-tank missiles deployed by NATO in Western Europe were mislaid at the critical moment, so that Britain was faced with an imminent invasion, then one of Mountbatten's successors as Chief of General Staff would be looking for effective means to repel it: such as large numbers of fast surface and submarine coastal defence vessels armed with modern guided missiles, large numbers of reliable and similarly armed interceptor aircraft and large numbers of surface to air and surface to surface missiles, properly deployed and ready for prompt territorial defence action. He would be offered instead Polaris (or Trident) nuclear missiles and the option of killing several million people in Moscow and some other Soviet cities. Or how about the last word in sophisticated supersonic penetrating long-range nuclear bombers? After all, over £20 000 million is to be spent on Trident and Tornado, so surely they *must* be useful to defend us against the looming threat of a Soviet invasion?



Press Association

'As a military man who has given half a century of active service, I say in all sincerity that the nuclear arms race has no military purpose. Wars cannot be fought with nuclear weapons. Their existence only adds to our perils because of the illusions they have generated'

(Earl Mountbatten, in his speech to the Stockholm International Peace Research Institute, Strasbourg, on 11 May, 1979. The full text is available from the World Disarmament Campaign, 238 Camden Road, London NW1 9HE.)

Evidently, if Mountbatten, Kennan and McNamara are right to conclude that nuclear weapons are "totally useless", there is an urgent need to face up to some questions about defence:

What on earth are we doing with a programme like Trident which proposes to increase the number of independent targets that can be struck by our submarine-launched missiles from 64 to something between 512 and 896, depending on the number of warheads per missile?

Why are we accepting a whole lot of entirely new American cruise missiles in this country which are unusable except in the context of an all-out nuclear war with the USSR, and about whose engineering design and performance there exist such grave doubts as to lead a recent study by Tim Williams (*The Ground Launched Cruise Missile, A Technical Assessment*, Electronics for Peace, 1983) to conclude that it is "an offer of hospitality to an untested, unreliable, bug-ridden system that could turn out to be fatal to its hosts"?

Why, indeed, do we not proceed immediately, unconditionally and unilaterally to phase out this whole panoply of expensive and dangerous nuclear junk and phase in a combination of hardware, strategic planning and positive security- and confidence-building measures that would together add up to a credible defence policy?

What is the underlying logic of McNamara's argument? In what ways could the possession of nuclear weapons by country X contribute to its defence? Let us suppose that country X is concerned with the threat to its political independence, national security or territorial integrity coming from country Y. There are two kinds of Y to be considered: a country that *has* nuclear weapons—let's call it Y_n, and one that does not—let's call that one Y_o. There are two kinds of threat (of attack) to be considered: a nuclear attack (N), and a conventional attack (C). The possible threat combinations are therefore (Y_n,N), (Y_n,C) and (Y_o,C).

The single exception allowed by McNamara to his conclusion that nuclear weapons are 'totally useless' was evidently the configuration $[X_n\times(Y_n,N)]$, that is, the nuclear capability of X deters the threat of nuclear attack by Y. I shall return to question the viability of this configuration a little later on.

The configuration $[X_n\times(Y_n,C)]$—nuclear deterrence of a postulated threat of non-nuclear attack by a nuclear power—is, of course, precisely what NATO's defence strategy is supposed to be about. McNamara himself was a central figure in the evolution of this strategy from "massive retaliation" to "flexible response", but now he has apparently come round, not full circle, but fully 360 degrees around a spiral that converges upon his conclusion that "nuclear weapons are totally useless". Over 6000 forward-based tactical nuclear weapons (which McNamara says should be cut at once to 3000 or less), an obstinate refusal to consider a "no first use" commitment, and the NATO modernisation plan to deploy 572 cruise and Pershing II missiles in Europe to replace a supposed missing rung in the ladder of escalation are the current manifestations of where the $[X_n\times(Y_n,C)]$ posture has led us. It is increasingly recognised as a perilous mess that has very little to do with security or defence.

As McNamara and many others have shown, this posture is unstable and will rapidly transform into an unacceptable variant of the first, namely $[X_n\times\times(Y_n,N)]$—a nuclear conflict $(\times\times)$ with a nuclear power. NATO nuclear policy, appositely described by Julian Critchley in a recent NATO document (Draft Interim Report of the Special Committee on Nuclear Weapons in Europe, London, October 1982) as "esoteric", postulates "flexible response" within a "limited nuclear war" which can be terminated (to our advantage), before it gets out of hand, by what is called intra-war deterrence, by which it is meant that the Soviets are deterred from going any further by the threat that NATO will step up to the next rung in the ladder of escalation. This is dismissed by McNamara and others as "absolute nuclear nonsense" (the phrase was originally used by Mountbatten).

What of the configuration $[X_n\times(Y_o,C)]$—nuclear deterrence of a threat of non-nuclear attack by a *non-nuclear* power? Leaving aside the niceties of who really has, or should have, sovereignty over the Falklands, it is evident that this configuration did not count for much with General Galtieri. In general, the use, or even the threatened use, of nuclear weapons against a non-nuclear power, under any circumstances, defensive or offensive, has now been recognised to be politically out of the question. This has applied even under extreme circumstances of imminent defeat, as for instance of the US in Vietnam.

One is forced to return to McNamara's one and only exception: $[X_n\times(Y_n,N)]$—"to deter one's opponent from using them". Is it a valid exception? Does one nuclear power really deter another from using nuclear weapons against it by a threat to commit not only mass murder but also mass suicide? Is this a *credible* deterrent? And even if it is, what on earth are we doing with over 50 000 nuclear weapons when a couple of hundred would be more than enough for deterrence. Does the escalation of the nuclear arms race that has in fact occurred not suggest that this old-fashioned deterrence configuration is inherently unstable? The dynamics of that instability has been well analysed by Lord Zuckerman in his book *Nuclear Illusion and Reality* and by others. Even if we ignore the incredibility and instability of the formula, does it not lead us into another difficulty? If the way to be safe when actual or potential opponents have nuclear weapons is to have them yourself, is this not a prescription for spreading nuclear weapons all around the world to as many countries as are foolish enough to believe in this nonsense?

It seems difficult to escape the conclusion that *none* of the X_n configurations offer a valid approach to defence, that *nuclear weapons are no defence.*

In that case, we have to ask what *is* genuine (and therefore 'non-nuclear') defence policy; we have to consider in detail and as concretely as possible the alternative family of defence configurations, the first of which is $[X_o\times(Y_n,N)]$—can a non-nuclear country be safe from a threat of *nuclear* attack? The credibility of such a threat suffers from the same political weakness as does the opposite configuration $[X_n\times(Y_o,C)]$, only more so. The threat (Y_n,N) is politically too expensive to be contemplated, or to be credible if made. The Soviet Union, for instance, could clearly not consider threatening to nuke Stockholm if Sweden refused to toe the Soviet line.

The configurations of serious interest are, of course, $[X_o\times(Y_n,C)]$ and $[X_o\times(Y_o,C)]$. They are what actual defence, as distinct from nuclear suicide, is all about. The details of what is needed to make such genuine defence policies effective and credible should now become the focus of our attention, once we have realised that Mountbatten really *was* right after all, and rid ourselves of the dangerous illusions that have been generated by our possession of nuclear weapons.

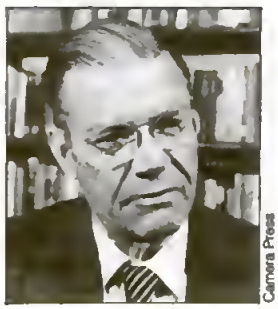
If we are seriously concerned about defence, as I believe we should be, then what weapons do we need and what strategies, and what will they cost? Most particularly, what non-military security-building policies are available to us, and what would *they* cost?

I have a strong suspicion that a serious examination of these questions will lead to the conclusion that we can indeed defend ourselves effectively without nuclear weapons and that it is by no means a foregone conclusion that genuine defence would be more costly than our present perilous self-deceptions. □

Popperfoto

'To my mind, the nuclear bomb is the most useless weapon ever invented. It can be employed to no rational purpose. It is not even an effective defence against itself.'

(George Kennan, in his speech of acceptance of the Albert Einstein Peace Prize, 19 May, 1981.)

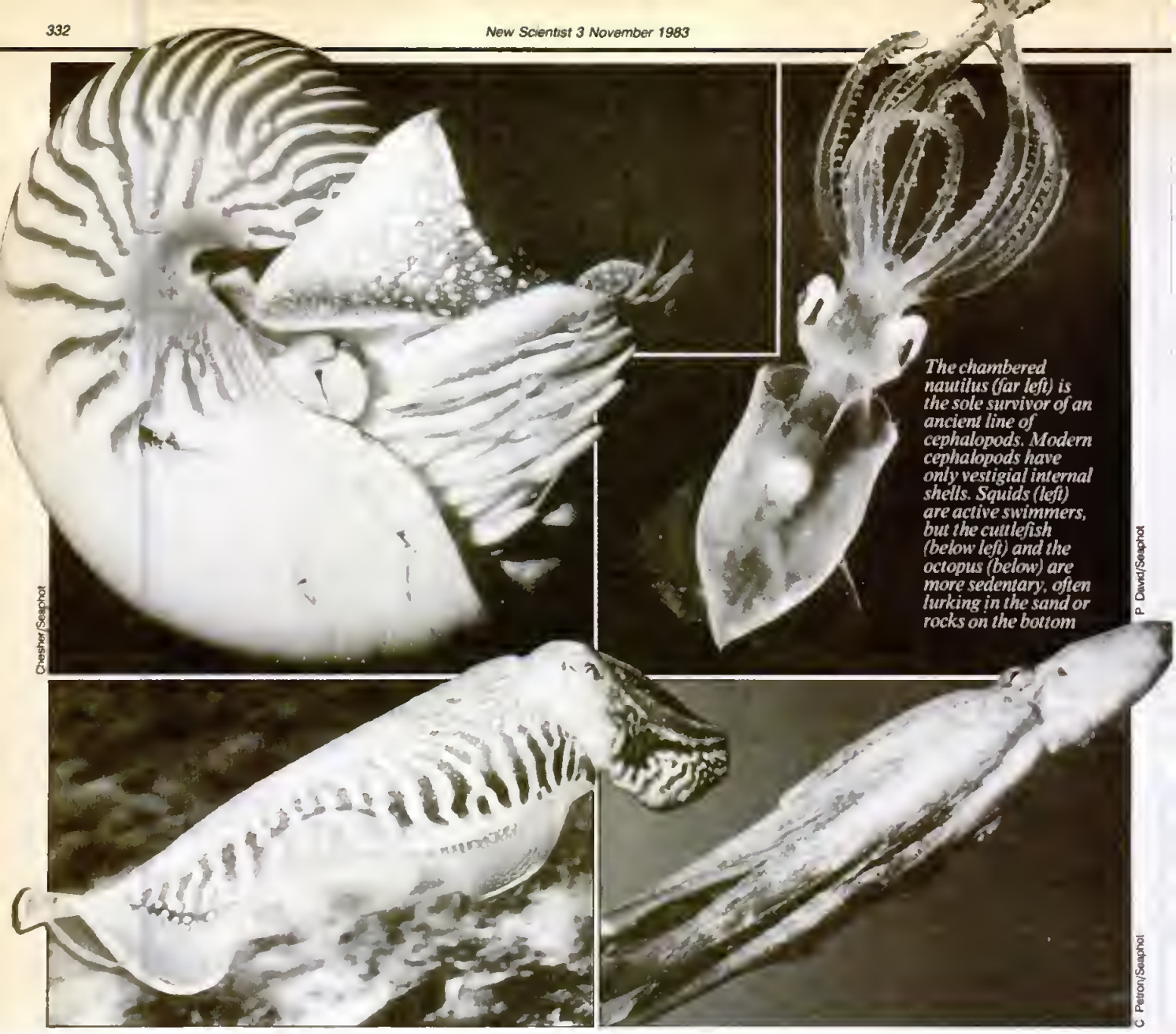


Camera Press

'I do not believe we can avoid serious and unacceptable risk of nuclear war until we recognise—and until we base all our military plans, defense budgets, weapon deployments and arms negotiations on the recognition—that nuclear weapons serve no military purpose whatsoever. They are totally useless—except only to deter one's opponent from using them.'

(Robert McNamara, former US Secretary of Defense, writing in Foreign Affairs, *vol 62, p 59, 1983.)*

Professor Mike Pentz is dean of the Faculty of Science at the Open University. He is national chairperson of SANA (Scientists Against Nuclear Arms) and a national vice-chairperson of CND.



The chambered nautilus (far left) is the sole survivor of an ancient line of cephalopods. Modern cephalopods have only vestigial internal shells. Squids (left) are active swimmers, but the cuttlefish (below left) and the octopus (below) are more sedentary, often lurking in the sand or rocks on the bottom

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Cephalopods do it differently

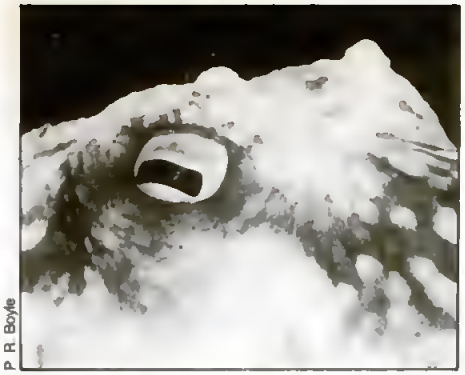
Octopuses and their relatives pose fascinating puzzles for the physiologist. These marine invertebrates are intelligent predators that in many ways rival the fish in the sea

Martin Wells

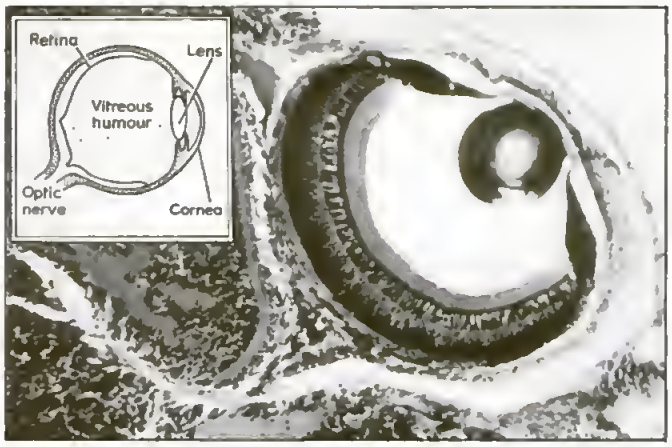
THE SQUIDS, octopuses and cuttlefish include the largest, fastest, and brainiest of all invertebrate animals. Although relatively unknown to the layman, cephalopods are, weight for weight, as common as fish in the sea. The ignorance of the average anglo-saxon arises because he can't catch them and wouldn't eat them if he could; a dead cephalopod is a horrid sight and if the fish fingers industry is homogenising them along with the rest, it has so far had the wit not to advertise the matter.

Elsewhere in the world, people know better, and cephalopods are the subject of large fisheries. The Japanese, ahead of the game in this as in so many other matters, ate more than half a million tonnes of cephalopods as early as 1952 (see Box 1). Factory ships are packing the squid in the North Atlantic, and there are innumerable small-scale fisheries from the Mediterranean to Polynesia. Our attitude is largely local and very short-sighted; this is what we shall all be eating if our present mismanagement of fish stocks continues.

To a zoologist, cephalopods have a value quite additional to their importance as protein, for cephalopods are Molluscs and could hardly be more distantly related to, our own, vertebrate kind of animal. Yet this apparently unpromising evolutionary material has given rise to animals that rival the fish in the sea, having solved, from a quite different starting point, a wide range of the same physiological problems. Fish and cephalopods inhabit a similar range of ecological niches. There are the octopods, lurking like groupers among the rocks, the bottom-living cuttlefish and sepiolids, hiding like flatfish in the sand and mud, the active shoaling squids and a range of strange luminescent forms hanging in the abysmal



P. R. Boyle



*The eye of the octopus (left) is uncannily like our own; it has a lens, muscles that can alter the shape of the lens, and a well-developed retina. A section of the eye of a juvenile squid (*Loligo*) (below) looks very like the human eye (diagram)—a classic example of convergent evolution*

depths. Competing in these ways cephalopods and fish have evolved back-up circulatory, excretory, digestive and nervous systems that are remarkably similar in function and sometimes even in their outward appearance. One has only to look an octopus in the eye to realise how dramatic this convergence can be.

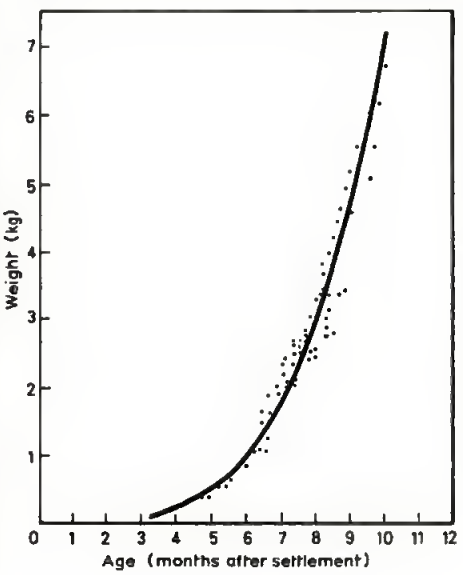
Which raises some interesting questions. Do the parallel systems that we observe in fact work in the same way? Are the solutions adopted unique—the only way a particular problem could have been solved with living material? And where we find differences, are these a matter of chance and ancestry, or indicative of differences in need that we might otherwise have overlooked? Comparative physiology is a worthwhile study, not only because we want to control and exploit other animals and because of the research tools that other species provide (the giant nerve fibres of cephalopods are at the base of the most of what we know about how nerves work) but also for the new ways of looking at things that stem from the use of a variety of material.

All of which is a plea for a study of the physiology of cephalopods. This is a neglected subject, for several reasons. One has already been mentioned; the western nations have scarcely realised that the creatures are economically important. The second is the difficulty of catching the animals—of which more anon. A third, and perhaps in the end the most important, is the distribution of facilities and personnel. Because many of them are large, and all are marine, living cephalopods can practically only be studied at marine biological laboratories or on board ship. Scientists at marine laboratories have, over the last century, had their work cut out simply to describe and map the animals and plants in their regions, so their emphasis has inevitably been mainly descriptive and ecological. It still is, in most parts of the world where cephalopods are readily available.

One consequence of all this is that much of the research on the physiology of cephalopods has been carried out by the members of university departments, on leave from their teaching duties or in the vacations when their students go away. So the work has been intermittent, patchy, and quite inappropriate to the scale of the need; here is the world's greatest source of untapped protein, and we have almost no knowledge of how to exploit it because we simply don't know how the creatures work. From the patches that we do know a little about it is becoming increasingly apparent that cephalopods are a very different sort of animal from ourselves, not only in their outward form, but also in their basic physiological processes. We will not be able to exploit cephalopods efficiently if we operate on the assumption that cephalopods are physiologically as well as functionally like fish, let alone similar to higher vertebrates.

To quote, then, just three examples. The reproductive strategy of cephalopods is unlike that of the overwhelming majority of fish, let alone the birds and mammals. These animals grow very fast—often from a few milligrams to a kilogram or more within a year—breed once, and die. Since the animals are all predators, often large and sometimes present in enormous numbers, one might reasonably expect a quite devastating impact on the ecology of the seas around them (see Box 2). But it is here that the very speed at which they put on weight is significant. The adults are sometimes large; but they spend only a small fraction of their life history as large animals. The growth curve of *Octopus cyanea*, in Hawaii, for instance, is exponential, so that although the animals may finally grow to a weight of several kilograms, they actually only spend two or three months at anything approaching this weight. There is no question of maintaining a stock of large adults from one year to the next. They die, and prey populations can recover before the next wave, with the young cephalopods exploiting different ranges of prey sizes and species as they grow.

Cephalopods grow fast because they convert prey to self with great efficiency. Few direct studies are available, mostly from species of octopod (octopuses, because of their sedentary habits, make better laboratory animals than the squids, which spend their lives swimming in the open sea). All indicate that octopuses convert prey into octopus at rates in excess of 50 per cent: a good broiler chicken can turn protein into protein at a rate of around 40 per cent. The cephalopod can do it (backed, let it be noted, by no breeding programme—goodness knows what rates geneticists will be able to squeeze out of cephalopods in the future), because its economy is almost totally protein-based. Protein for growth, protein for fuel, and protein for energy storage. A marine animal (unlike a chicken) can break protein all the way to ammonia, and is untroubled by bulk. With abundant water there is no need to excrete a less toxic intermediate product (such as urea or urine), and no need to synthesise fat to avoid the weight penalty of a wet protein store. The reserve can be



Octopuses grow incredibly quickly, exponentially, as this growth curve for Octopus cyanea *demonstrates. An octopus can turn prey into its own flesh more efficiently than broiler chickens which have been specially bred to convert food into chicken. Once the octopus reaches its adult weight it reproduces and quickly dies. All of which makes the octopus an ideal "farm" animal*

1: Japan is number one squid-eater of the world

WHEN it comes to scoffing squid, the Japanese are undisputed world champions. They consume as near as makes no difference half the total annual world catch, five times more than their nearest rivals the Chinese, and 10 times more than the European champions, the Spanish (who rank seventh in the world). Although Japanese have been eating squid for more than 1000 years—the first recorded mention was in 907 AD—in the post-war period, their appetite has become voracious. Over the past 20 years they have been putting away an annual average of over half a million tonnes, and in a good year (such as 1968) can let out their belts sufficiently to accommodate three-quarters of a million tonnes of molluscs.

Somewhere in the region of 37 000 boats are wholly or partly involved in catching squid. Of their total haul, roughly 70 per cent comes from coastal fishing, 20 per cent (frozen) from deep-sea boats voyaging as far as New Zealand and Argentina, and the rest is imported (dried) from countries such as Thailand and Canada. In a country that gets almost a quarter of its daily protein intake (80 g per individual) from the sea (as opposed to less than 2 per cent in the UK), the ubiquitous cephalopods provide at least 5 per cent of that figure.

Although many kinds of squid are eaten in Japan, until recently one kind—*surume ika* (*Todarodes pacificus*)—was the overwhelming favourite. In the past 15 years, however, overfishing and other factors have brought the catch down by a half, pushing the price up in the process. The shortfall has been made up by *aka/murasaki ika*—red/purple squid (*Ommastrephes bartrami*)—which fishermen used to throw away. Another reason for the newcomer's popularity—up from less than 100 000 tonnes in 1965, to more than 300 000 in 1981—is that they are caught in the winter, whereas the *surume* season is from April to November.

Setsuko Nakaki

The market at Tsukiji in Tokyo: squids in from the local fishermen

How are squid caught? One of the main in-shore fishing areas is the south-east (Pacific) coast of Hokkaido, northernmost of Japan's four main islands. Throughout the season, boats go out from small village harbours day and night. Of the two main types of boat, the larger ones—*ika-zuri*—are the night fishers. They carry rows of powerful electric (formerly charcoal) lamps to attract the schools of sharp-eyed squid. Strung out along the horizon, the lit-up boats are easily mistaken for a distant town. Fishing is by line, and lines, carrying up to 50 hooks each, are mechanised, reflecting not only a desire for efficiency, but also the fact that the average age of the fishermen is over 50. The mayor of one village said that his biggest headache was trying to persuade young people to forego the lure of the big city and stay to man the boats.

The other type of boat—*daibo*—does not, however, have such a serious manpower problem, relying as it does on part-timers. These boats go out in pairs with 12 to 15 men on board twice a day (once in the early morning, once in the afternoon) to haul in squid—and fish—caught in permanent nets. Some of the better-off fishermen apparently have radar in their homes so they can tell when the nets are full!

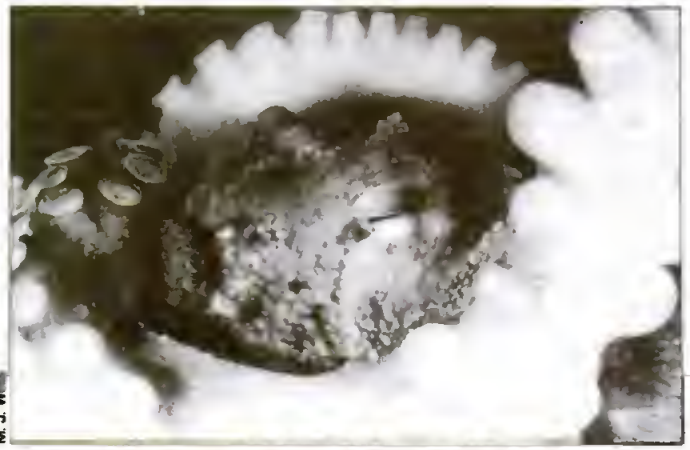
Hauling in the nets is a lively scene: the squid—about 22 cm long and pearly-brown in colour—hurl themselves frantically into the air, squeaking shrilly, only to be packed helplessly into polystyrene

the body musculature itself, which allows for very rapid growth when the going is good.

The run up to the reproductive holocaust has to be very precisely timed, and here we have found a mechanism with close functional parallels to that in vertebrates. The animals must begin to prepare for reproduction in the early part of the year in which they breed. We do not know the precise nature of the environmental triggers in any cephalopod, although it seems likely that day length is important here as it is with many other animals. What we do know is that the next stage operates through the highest levels of the central nervous system, areas just below regions of the brain known to deal with sensory analysis and learning. The critical part of the brain, the subpedunculate lobe, controls an endocine gland, the optic gland. This gland is the source of a gonadotropin (a class of hormones) that is the immediate cause of a massive switch in the economy, from bodily to reproductive growth. The proximity of the higher brain centres to the control centre itself suggests that some quite sophisticated assessment of the environmental situation must lie behind the "decision" to go for reproduction; and similarity to the hypothalamic and pituitary control system in vertebrates is quite striking. The two systems differ considerably, however, when the matter is examined in detail. There is, for example, no evidence of sex hormones produced by the gonads, in cephalopods. The growth of sex ducts depends upon the same optic gland hormone that controls both protein synthesis, in the gonads, and the breakdown of proteins in the stores elsewhere, while sexual behaviour is apparently a wholly intellectual matter, unsullied by hormonal influences.

One consequence of the nature of the cephalopod control system is that by destroying the optic glands it is potentially possible to switch off both the onset of sexual maturity and the cessation of exponential growth. It raises the awesome possibility of producing broiler cephalopods in which growth would only be limited by the capacity of the circulatory, excretory and digestive systems.

Circulatory physiology is another instance where it now



M. J. Wells

Octopuses take life calmly most of the time

seems that cephalopods differ very considerably from their vertebrate competitors. On the face of it, the similarity is striking. The cephalopods have a fully enclosed blood system—a rarity among invertebrates—with a systemic heart, arteries, capillaries and veins. In fact the functional parallelism is with the higher vertebrate rather than fish, for cephalopods have separate pumps for their respiratory and systemic capillary beds—the gill hearts paralleling the right and the systemic the left ventricle of terrestrial vertebrates; fish have a functionally more primitive system with the gill and body capillaries in series.

Differences appear as soon as one begins to study the performance of the two systems in detail. For a start, cephalopods modulate pressure where most vertebrates would tend to change the frequency of heart beat, so that changes in the volume of blood passed are achieved by different means although the final effect is the same. The difference reflects the absence of a jointed skeleton in the mollusc. Vertebrate muscles extend their antagonists by a system of levers, so that

boxes full of ice the moment they hit the deck. When the boats come in, the boxes are carted off to the local city of Hakodate, and thence to next morning's markets, such as Tsukiji in Tokyo.

A villager buying straight off the boat would expect to pay about £2 a kilogram—about five squid. By the time the same squid reaches the fishmongers in Tokyo, the price will have gone up by about four or five times. And although the total quantity of squid caught in Japan continues to grow, the relative amount has dropped against cheaper fish, especially sardines.

Peggy Ross

Japanese fishermen net a shoal of squid

Given that they've had more than 1000 years to experiment, it's hardly surprising that the Japanese have dreamed up plenty of ways of preparing squid. The first part is easy: pull out the tentacles (and put aside), lop off the head, remove ink-sac, guts and cuttle-bone (which, incidentally, is sometimes dried, powered and used for animal feed), trim off the tail (which *is* rather chewy), peel the skin off the mantle and rinse mantle thoroughly. Much fresh squid is eaten raw, in one of two ways—as *sashimi*, thin slices dipped in a mixture of soy sauce and *wasabi* (Japanese horseradish), or as *ika-somen* (" squid noodles") which are eaten with soy sauce and grated ginger. The taste is hard to describe—very delicate, and the texture not chewy. Either of these dishes might be served for any meal (including breakfast), and the leftovers eaten the next day, after a brief immersion in boiling water, just long enough to turn the translucent flesh opaque.

Remember those tentacles? Well, one way of preparing them is to chop up into one-centimetre chunks, pack into a jar with vinegar, salt, ground red pepper and some squid liver, then leave them to pickle. The resultant delicacy, *shio-kara*—"salty-and spicy"—can be an ordeal for some. "Rubbery, crunchy and slimy," was one brave soul's verdict.

Cooked squid dishes tend to be more approachable. One popular method of preparation is to stuff the mantle with, say, rice (*ika-meshi*). For this dish, the stuffed sac is closed up with toothpicks, and the whole is boiled then simmered in soy sauce, sugar, *sake* and water for about half-an-hour. Before serving, slice into rounds—very tender. A typical way of cooking squid in winter is in *oden*, a hotchpotch which also contains *daikon* (Japanese radish, *satoimo*), taro—*Colocasia antiquorm*—and fish paste.

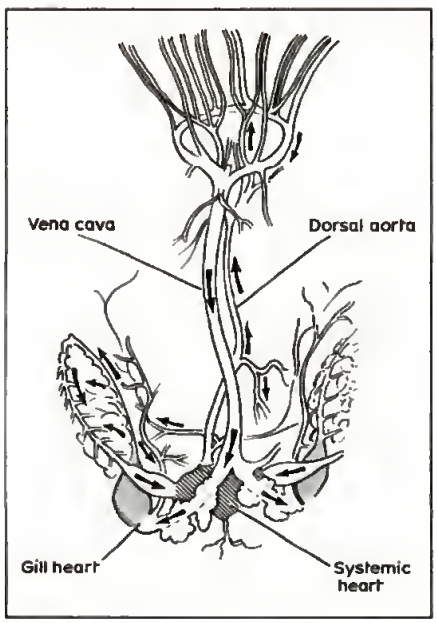
All these dishes are made from fresh squid. Until the introduction of refrigerated transport, however, virtually all squid eaten in non-coastal areas was dried. Today, though estimates vary, anything up to 40 per cent of all squid is processed before eating. Of the many varieties, the most popular is *saki ika* ("shredded squid"), which comes in packets and is eaten as a snack food, often with beer, like potato crisps. *Saki* made from dried squid is of course *very* chewy. Since the war, however, a new method of production using semi-dried (that is, still somewhat flexible) squid has been developed. The product, "*soft-saki*", now accounts for some 70 per cent of processed squid sales. Other squid snacks include smoked *saki*, squid-and-cheese slices and squid-on-a-stick. And other new squid products are appearing all the time—would you believe squid sausages?

Bob Johnstone

Bob Johnstone is a freelance writer based in Japan.

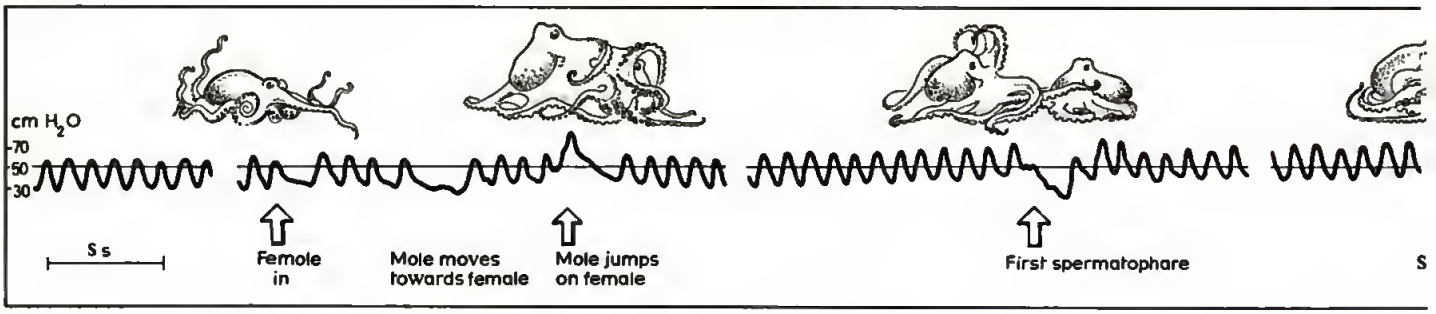
there are always relaxed muscles being extended when the animal is moving about. Extension sucks in the blood which is pressed out again when the muscle contracts; passive valves determine the direction of flow. In an animal without hard parts, muscular extension can only be achieved by squeezing the muscles out under pressure, so that movement does nothing to assist the flow. Rather the reverse; a massive increase in blood pressure is needed to maintain any sort of circulation, a matter that should, to say the least, be interesting to a species where hypertension spells potential disaster.

The blood itself is very different from our own. It does not clot, so that wounds are sealed off by contraction of the blood vessels until wandering white cells can assemble and lay down connective tissue. Damaged areas are sealed off at once and very efficiently, to the despair of neurophysiologists who find that their preparations go "dead" as they open them up to poke in their electrodes. The blood pigment is copper-based haemocyanin, not iron-based haemoglobin like our own, and there is no equivalent of the vertebrate red blood corpuscle. Perhaps because the pigment cannot be packaged in this manner,the oxygen-carrying capacity of the blood is pitiful by vertebrate standards—3-4 vols per cent compared with 10-15 vols per cent in fish. Cephalopods make the best of a bad job by extracting a much higher proportion of the oxygen each time the blood goes round, so that the return to the gills contains less than 0·5 vols per cent even at rest. This is bad news for the active cephalopod, because it means that there is no scope for increasing oxygen extraction from the blood, as there is in a vertebrate. Taken together with the pressure problem, which effectively prevents an increase in heartbeat frequency, it means that the metabolic scope (the increase in metabolic rate that is possible in times of stress) is very limited; available figures suggest maximum increases to about 3 times the resting rates (a good active fish can manage 5-10 times). Laboratory experiments here tell us something about the lives of squid and other cephalopods in the sea. Jet propulsion gives them great manoeuvrability and enormous acceleration to catch prey or avoid predators. But it is far too extravagant in fuel to be maintained aerobically; the animals must sprint on oxygen debt and pay back while finning gently along between times. There is no question of their maintaining a continuous fast-swimming lifestyle comparable with a mackerel or a tunny.



An octopus has a double circulatory system, analogous to that in humans. It has a systemic heart (equivalent to the left ventricle in humans) which pumps blood to the body. Two accessory hearts (equivalent to the right ventricle) supply the capillaries in the gills. Fish have a more "primitive" system, with gill and body capillaries in series, fed from a single ventricle

Some cephalopods—octopuses and cuttlefish—live in dens or buried in the sand on the seafloor, where the oxygen content of the water they breathe may be low: the capacity to maintain oxygen uptake when oxygen is short is potentially important. And here again, cephalopods have developed a mechanism that is odd by vertebrate standards. Instead of shifting more, less well oxygenated blood, or extracting a higher proportion of the oxygen at each circuit, they increase



the blood *p*H, increasing the affinity of the blood pigment so that it saturates at a lower ambient oxygen tension. Again, it is an alternative answer and (in this case rather a good one, since it does not involve extra expenditure of energy in additional pumping). Cephalopods, almost anywhere one looks, do it differently.

The sensory equipment and central nervous system of cephalopods have attracted much attention, largely because the octopods, at least, are so plainly intelligent. The classical experiments of J. Z. Young, working at the marine biological laboratory in Naples, showed years ago that octopuses can perform quite as well as mammals in discrimination experiments. Young was able, moreover, to unravel to a considerable extent which bits of the brain do what, so that the cephalopod central nervous system is still one of the best mapped, both anatomically and functionally, that we have outside of the rats, cats and monkeys. All the evidence indicates that learning in a cephalopod must depend upon very similar mechanisms to learning in vertebrates. Thus it seems to depend upon a succession of short and long term processes; the former, with a time scale in minutes, are readily disrupted; the latter—long-term memories—may last for a lifetime once established and cannot be disrupted by shocks or anaesthesia. The structures associated with long-term storage, myriads of small cells, mostly with only local connexions, again recall vertebrates. And there are parallels in the relation between cell numbers and resolution, and the apparent lack of localisation of memory traces within small cell areas that imply that learning in cephalopods and vertebrates must somehow depend upon very similar mechanisms. Perhaps there really is only one way of putting neurones together to raise a long-term associative learning machine.

2: Squids in the sea—and down on the farm?

CEPHALOPODS, the largest and the fastest-growing invertebrates alive today, are potentially a major source of protein for people. Adult octopuses can weigh up to 50 kg (*Octopus dofleini*), and rare giant squids (*Architeuthis*) range up to 500 kg. They apparently reach these weights remarkably quickly. Cephalopods in captivity put on 3 to 5 per cent of their body weight each day; most reach their adult size within a year or two of hatching.

This rapid growth rate is one logistic reason why cephalopods have such enormous potential as a human food source. With fish, of every one year-group of individuals that are big enough to catch, there will be several other year-groups, almost as big individually and possibly far bigger en masse, that are eating their heads off. With farm animals the problem can sometimes be far worse: thus in order to produce one steer, the farmer has to feed it for two years; and to produce one fat lamb, he must not only feed it for six months, but also maintain its mother for a whole year. With squid and octopus, the only animals that are actually eating large amounts at any one time are the ones that are ripe for the cooking pot.

Cephalopods aren't being commercially farmed at the moment, but they are being harvested from the sea on a small scale, in most parts of the world. Even fishermen off Cornwall and Scotland are now catching limited amounts. Caught by trawls, seines and a variety of lures and jiggers, about 1·5 million tonnes are currently landed throughout the world each year. Many fisheries specialists believe that these resources could be exploited more intensively.

The principal difficulty facing the expansion of cephalopod fisheries, apart from the practical problems of catching them, is predicting where and in what quantity they may be found. The density of populations of squid and octopus varies dramatically from year to year. With a lifespan of only a year or two, the stock is almost totally dependent on the number of young produced the previous year. So far, it is difficult to calculate the traditional fishery statistics such as "stock size", "production" and "sustainable yield" with reliability.

P. Talbot

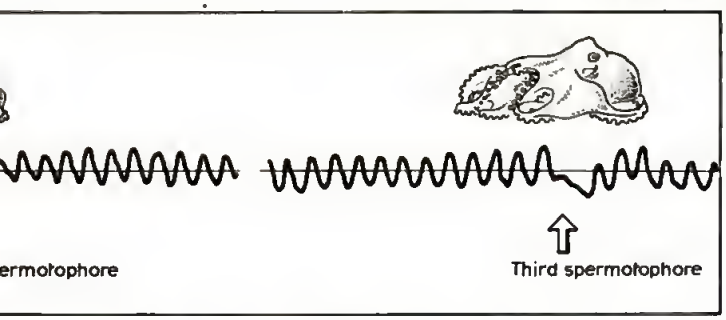
From Cornwall—squid fingers?

Other marine predators, however, already make comprehensive use of cephalopods as food. Analyses of the number and size of cephalopod beaks—their chitinous feeding equipment—that remain in the stomachs of many species of marine mammals and birds enable us to quantify some of these feeding relationships. Sperm whales seem to be important predators of squid in deep water. Using conservative figures for the 1972 stock of sperm whales and their feeding rate, Dr M. R. Clarke of the Plymouth Marine Laboratory estimates that the whales consumed at least 100 million tonnes of squid in that year.

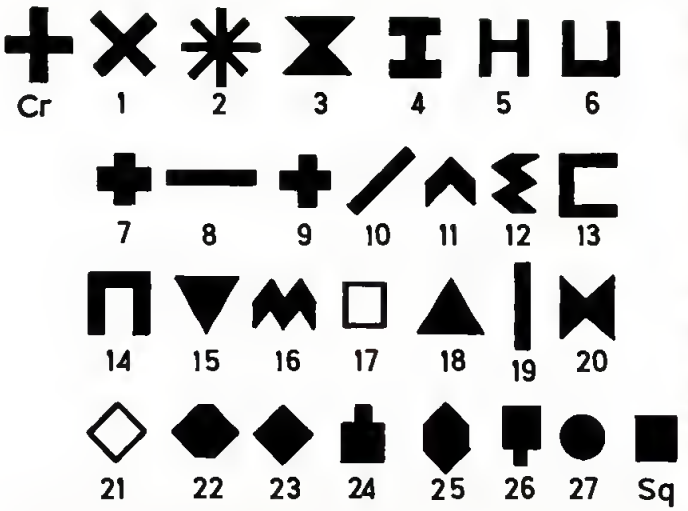
This figure must be compared with the world landings of conventional fish stocks—about 65-70 million tonnes—to appreciate the scale of this consumption. And sperm whales are only one of the many predators taking squid. These numbers are even more startling when we consider that squid eaten by whales are themselves predators and therefore at the third level, at least, in the food chain—biomass generally declines markedly as one moves up trophic levels, making predators scarcer than prey.

We still know very little about life cycles and population biology of the cephalopods. Even so, they do seem to show a combination of biological features which is unusual and difficult to reconcile with conventional views of marine ecology. Their large adult size and rapid growth must be due to their efficient feeding and conversion of food, as well as their highly nutritious diet. As predators, perhaps at the third or fourth link in the food chain, it is remarkable that they live for such a short time and breed only once. There are undoubtedly substantial numbers of cephalopods in the sea, and only a small fraction are currently exploited by humans. The energetics of this massive production of cephalopod flesh, combined with the apparently paradoxical features of their life cycles, are topics which are increasingly catching the attention of marine biologists. □

Dr P. R. Boyle of the Zoology Department in the University of Aberdeen kindly assisted in the preparation of this box. He is editor of *Cephalopod Life Cycles*, soon to be published be Academic Press.



Recordings of the heartbeat of a male octopus during a romantic interlude. The male's heart missed a beat when the female was dumped into his tank. But he lost no time in grabbing her and inserting his hectocotylus, a specialised tentacle that bears spermatophores (packaged sperm), into her mantle cavity. His heart also missed a beat at each ejaculation. But there is no sign of a racing pulse; octopuses take these things very calmly. In the early stages of mating, the male may display the large suckers on his second and third right arms, perhaps to advertise his sex



Octopuses can distinguish between these shapes (above) by sight. Stuart Sutherland of the University of Sussex trained octopuses to discriminate between a cross and a square, by giving them rewards of food when they attacked, say, the cross. He then observed how they responded to the other shapes. The numbers show the order in which the octopuses ranked the shapes. They tend to classify shapes along a dimension that seems to depend upon the relation of outline to area—"open" shapes such as the cross have a larger perimeter in relation to its area than the "closed" forms such as the square

From the practical point of view of someone who wants to understand how cephalopods distribute themselves, how they find their way about, and how to catch them, it is of course not so much how they learn as what they learn that matters. The fact that they do learn so readily makes it rather easy to investigate this. From their successes and failures in discrimination experiments we can gain a very fair idea of the world in which a cephalopod lives.

It seems, for a start, that the animals are overwhelmingly dependent upon vision (here, and always, it is necessary to add a caveat, because we know almost nothing about the deep-water oceanic forms, most of which have never been kept alive in aquaria). The animals are apparently deaf, and there is no equivalent of the lateral-line pressure sensitive system of fish. It is this lack, paradoxically, that in a large measure protects them from our own unfriendly attentions. It is possible to fool a fish into the cod-end of a trawl because it feels the obstruction presented by the lines to the otter boards and shies away. A squid sees the wide-mesh arms of the net ▸

P. Morris/Ardea

Illustrated London News

Octopuses are active predators: they catch their prey, such as crabs, by leaping on them

MOUNTBATTEN WAS RIGHT!

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SAVED FROM AN OCTOPUS BY FAIRIES AT THE HIPPODROME.

Illustrated London News

and swims straight through it.

Vision is acute and the animals are plainly able to distinguish sizes and shapes. Strangely, for creatures that are themselves often so brightly coloured, cephalopods turn out to be colour-blind. The bewildering capacity for camouflage that makes littoral species like *Octopus* and *Sepia* so difficult to locate and pursue is based upon nervously controlled chromatophores in a very limited (yellow through red-brown to black) range of colours. The animals match intensity since they cannot distinguish wavelengths, and they rely upon reflective elements in the skin to pick up the greens and blues from their environment. Disruptive intensity patterning, flickering with change, mimics the changing light and confounds the search-image of would-be predators. If all else fails the cephalopod can discharge a bolus of ink—the pigment melanin in a mucous carrier—to distract the opposition while it escapes. The survival of these unarmoured and softly edible creatures shows that the deceptive repertoire is quite good enough to defeat fish, nearly all of which have the apparent advantage of good colour vision.

In compensation, as it were, for the absence of wavelength discrimination, the eyes of cephalopods have evolved an alternative capacity that has remained undeveloped in vertebrates. Cephalopods can detect the plane of vibration of light. This is apparent at the level of individual receptors, each of which responds maximally to light polarised in the horizontal *or* the vertical plane. It is obvious that the internal wiring is laid out to preserve the difference, since *Octopus* at least can readily be trained to distinguish between light sources—indistinguishable to us—polarised in the horizontal and vertical planes. What use the animals make of the capacity is at present unknown. Other invertebrates use polarisation planes for navigation (honeybees are the classic case) and with the degree of plane-polarisation that is inevitable when sun or moonlight strikes a water surface at an acute angle, it seems not improbable that cephalopods too are finding their way about by this means. Alternatively, it is possible that the animals are wearing built-in sunglasses. One of the two sets of receptors will always be able to see through a reflection that would otherwise blind the animal to internal detail. But once again, there is a lamentable lack of information. In a vertebrate or an insect we would at least have an inkling of what was going on. In the case of the third pinnacle of animal evolution we are nearly always sadly ignorant. It is an undeveloped country, so far largely ignored because the immediate cash pay-offs of development have not been obvious. Yet these animals compete for our food (as the insects do), are supremely edible (which to most tastes the insects are not) and have much to teach us about the physiology of higher animals, from how nerves work to how to cope with hypertension.

It may be as unwise to neglect this third world as that of the "underdeveloped" members of our own species. □

Dr M. J. Wells is a senior lecturer in the Department of Zoology at the University of Cambridge.

MONITOR

Gene cloned for nerve wrapping

Nancy Heneson

SCIENTISTS in California have isolated and cloned the gene that codes for the major protein of myelin, the fatty sheaths that encase all the nerve cells.

Myelin is vital to the conduction of nerve impulses; loss of, or defects in its structure can lead to several human neurological diseases including multiple sclerosis. The Californians have demonstrated that the gene for myelin basic protein (MBP) is defective in a strain of mouse with a myelin-related nervous disorder (*Cell*, vol 34, p 799).

The gene for myelin basic protein (MBP) was isolated by Leroy Hood of the California Institute of Technology and Stanley Prusiner of the University of California at San Francisco. Copies of rat DNA were inserted into the DNA of *E. coli* which through its own DNA synthesis produces copies (a "library") of the rat genome.

The researchers knew already the arrangement of amino acids that make up the basic protein of myelin. From this they worked out the sequence of nucleotides that are necessary to produce the protein. Armed with the "genetic code" for MBP they searched the "library" for identical sequences. But how to locate the sequences in the library? The scientists used a machine which was developed at Caltech and is capable of making what are known as DNA "probes". First they built short sections of DNA (14 bases long) that coded for parts of myelin basic protein. These

Jerry Mason

Shivering mice may hold clue to human neurological disease

short strands were then labelled with radioactive phosphorous (32_P). When mixed with individual strands of the rat DNA, these radioactive DNA probes stuck to copies of the MBP gene, tagging them. The researchers simply had to look for the "tags" to isolate the complete gene.

The Caltech-UCSF team then used the MBP gene to investigate the DNA of "shiverer" mice, a strain of mouse that develops shivering, seizures and paralysis because of a defect in the structure of its myelin. They found that large portions of the MBP gene is missing in these mice.

The obvious next step is to replace the defective MBP genes in shivering mice with normal copies, to find out if the disorder is corrected. However, the implications for human disease are not quite as straightforward. Multiple sclerosis, for example, is generally thought to be an auto-immune disease—that is, where the body's immune system attacks its own tissues instead of foreign invaders. The question is what triggers such a response from the immune system? In the case of multiple sclerosis, there are many hypotheses in the nature of the trigger, but none are testable.

One hypothesis favours a genetic origin for the demyelination process in multiple sclerosis, and is supported by some clinical evidence of the disease running in families. The isolated MBP gene provides, for the first time, a way to test this hypothesis. Researchers can probe the DNA in blood samples taken from patients with multiple sclerosis, their relatives, and others considered to be at high risk, and examine the myelin protein sequence for abnormalities. However, as one of the Caltech researchers cautioned, even if the MBP gene of patients with multiple sclerosis is found to be defective, as in the shivering mice, there is no guarantee that the normal gene will correct all the problems seen in patients with multiple sclerosis. □

X-rays reveal galaxy stripping

THE GALAXY in this picture is undergoing a cosmic crash that is turning it from a spiral galaxy into an elliptical. This conclusion follows from observations with X-ray and radio telescopes, and it is the first direct evidence for a theoretical idea that has been around for years. The galaxy, catalogued as NGC 4438, is a member of the nearest large cluster of galaxies, the Virgo Cluster. Lying some 50 million light years away, the cluster consists of thousands of individual galaxies, and a pool of hot gas in the cluster's centre (off to the lower left of this picture). The galaxies are of two types. Some are spirals, like our Milky Way, with a disc of young stars, gas and dust surrounding a hulge of old stars .

Others are elliptical galaxies. As their name suggests, they are oval-shaped balls of stars, rather like the central hulge of a spiral galaxy. Unlike a spiral, an elliptical galaxy consists entirely of old stars. Not only does it lack young stars, it is devoid of the gas and dust from which young stars form. Astronomers originally thought that ellipticals were simply galaxies where all the dust and gas had turned into stars when the galaxy was born. But now we know that stars continuously lose gas into space, so a galaxy consisting only of stars should by now have filled up with gas again. There must be a mechanism which can strip gas away from galaxies after they are born. The fact that ellipticals are much commoner in clusters of galaxies containing a central pool of hot gas suggests that elliptical galaxies were originally spirals, and that their interstellar gas has been stripped away when they ploughed into the cluster's huge gas pool.

Kitt Peak National Observatories

NGC 4438 (top left) is distorted by the collision with gas in the Virgo cluster. As the galaxy moves from top right to lower left, its own gas is left behind like trailing wings

Optical photographs like this show mainly a galaxy's stars, which are not stripped away, but X-ray and radio observations reveal instead its interstellar gas. C. Kotanyi of the European Southern Observatory (based in Germany), and J. H. Van Gorkom and R. D. Ekers of the US National Radio Astronomy Observatory have recently looked at the galaxy's X-ray emission with the orbiting Einstein Observatory, and at its radio output with the Very Large Array in New Mexico.

The observations show that the galaxy's interstellar gas produces about the same amount of emission as the gas in a normal spiral galaxy. But instead of lying symmetrically around the galaxy's core of old stars, the gas in NGC 4438 is all displaced to the top right. The only simple explanation is that NGC 4438 was originally a spiral galaxy, on a path from right to bottom left as seen here. Near its present position it ran into the edge of the pool of hot gas in the centre of the cluster. The stars have carried on unaffected, but collision with the gas pool has stopped the galaxy's gas and dust (upper right). When this gas dissipates, all that will be left is the stripped star core of NGC 4438—a newborn elliptical galaxy. □

MONITOR

Dust ring around the Sun . . .

WHEN all the planets had been formed, what happened to the material that was left over? Some of it came to form a ring of dust around the Sun. That such a ring existed has been known for some time—it is thought to be the cause of zodiacal light—hut it has thwarted all attempts to observe it, the problem being its proximity to the Sun. During last June's total solar eclipse, however, a team of Japanese scientists sent up a balloon containing instruments which managed to make recordings of the ring at several different wavelengths. Their findings, announced at a recent meeting of the Japan Astronomical Society, should shed light on how solar systems are formed.

Like *New Scientist* (vol 98, p 875), the Japanese team (seven scientists from the Tokyo Astronomical Observatory, the Institute of Space and Aeronautical Science and Kyoto University) picked Indonesia as the best place to make their observations, because there they would have several minutes of eclipse to play with. They made their experiments with the help of scientists from the Indonesian National Institute of Aeronautics and Space.

Previous attempts to capture pictures of the dust ring—also known as the F corona—have failed because they were made from the ground. To get above the prohlems caused by the background brightness of the sky and the atmosphere's ability to absorb infrared radiation, a balloon is the obvious answer. Packed into the gondola of the Japanese team's balloon were a highly sensitive silicon intensifier target TV camera with built-in occulting disc to block light 'blooming' from the Sun's inner corona, and an infrared scanner with a 15-cm reflector. They sent all this aloft at 7:13 on 11 June, about four hours before the eclipse took place, to a height of just over 30 kilometers.

In the event, four years of planning paid off; even the wind behaved itself. The eclipse lasted 3 minutes 50 seconds, during which time the balloon's instruments were kept trained on the Sun under an attitude control of within 15 arcseconds. Observations made at four visual and four infra-red wavelengths all add up to the same conclusion. There is a ring (or, more accurately, a flat plate) of dust at a distance of about 3·8 solar radii from the Sun. Its main components are silicate grains, approximately one million tonnes of them, whose temperature is about 1300° C.

The team is still working on its findings, One team member, Syuzo Isobe of the Tokyo Astronomical Observatory, told *New Scientist* that there had been several recent sightings of flat, circular plates surrounding other stars. Comparing the matter surrounding our mature Sun with that around a young star like those in Orion could provide much information on how planetary systems are formed. □

. . . and clouds around the Earth

HISTORIC dry fogs in Europe, acid precipitation in Greenland, and major explosive volcanic eruptions between 1500 BC and AD 1500 have all been correlated with the aid of ice cores drilled from the Greenland glacier. By putting the historical accounts on a quantitative base, this offers a useful way to calculate the amount of volcanic debris in the atmosphere at different times, and to improve our understanding of the volcanic effects on climate.

So say Richard Stothers and Michael Rampino, of the NASA/Goddard Institute for Space Studies, in New York. They have used Greenland ice core data obtained by a Danish team, and compared these with historical descriptions of atmospheric conditions in the years after great volcanic eruptions. The ice cores give a direct measure of the changing acidity at the time the ice was being laid down, and this depends in part on the production of sulphur dioxide by volcanoes. Deeper layers of ice are older, so that eruptions can be roughly dated by measuring the depth of acidity concentration below the surface of the ice. Then, a comparison with historical records shows, for example, that a peak dated in this way as 50 BC±30 years corresponds to the historical eruption of Etna in 44 BC, when a great dry fog spread across Europe (*Science*, vol 222, p 411).

Mary Evans

Pompeii: destruction written in the ice

The importance of the new study is that it shows that the atmospheric aftereffects often described hy contemporary observers and assumed by modern climatologists to be the result of historical volcanic activity really are related to large eruptions. This makes it much more acceptable to rely on the historical descriptions of atmospheric effects even for periods and regions of the globe not covered by the ice core data. In addition, by using the major eruptions to calibrate the ice core, it is now possible to date precisely the smaller eruptions which have left their trace in the ice but received no mention in the histories and legends. □

How vitamin C can help you to stay healthy

TAKING vitamin C may be just as good as taking vitamin E in the fight against growing old, or so a recent paper in *Chemistry Letters* (p 631) would seem to suggest. Both individually and together these essential chemicals act as antioxidants, protecting the body's cells against the ravages of oxidation.

Organic materials such as edible oils, fibres and plastics are all prone to gradual deterioration as a result of oxidation by the oxygen of the air. Nor are living cells exempt from this slow oxidation and one theory of ageing is based on the decline of the body's natural defences which counteract the pathological affects of this chemical (non-enzymic) type of oxidation.

On the other hand the oxidation of fats, carbohydrates and other components of our food is essential for our well being, but this oxidation is carefully controlled by enzymes and the waste products of such reactions are carbon dioxide and water, which are harmless. The products of non-enzymatic oxidation, however, are peroxide free radicals, $RCOO^{\cdot}$, which have a free electron, or the superoxide ion, O_2^{-}.

These dangerously reactive species can trigger many undesirable chemical reactions in the living cell and perhaps mark the beginning of cancer. The body has developed so-called, free radical scavengers or antioxidants, to mop up these dangerous substances and vitamin E is the best known of them. The simplistic view that vitamin E counters ageing is based on its antioxidant properties.

Studying the chemical reactions of vitamins in the living cell itself is beyond present capabilities, so Etsuo Niki, Tadatoshi Saito and Yoshio Kamiya of the Department of Reaction Chemistry at Tokyo University, have devised a chemical system to test the antioxidant behaviour of vitamins in the laboratory. They chose methyl linoleate as their model fat and dissolved it in a mix of solvents and other substances that initiate free radicals. The system was kept at body heat (37° C) and the amount of oxygen which was consumed was measured.

When vitamin E was present in the solution the oxidation was supressed until all the vitamin was used up in counteracting the free-radicals. Vitamin C was also found to be a good antioxidant, but not as good as E. A mixture of C and E was observed to be as good as E and the researchers concluded that the role of C was to regenerate the spent vitamin E.

A synergic, that is, mutually beneficial, relationship between C and E has been observed in rats. Now a sound chemical reason for this has been proved in the laboratory. The conclusion would seem to be that excess vitamin E in the diet is unnecessary—extra vitamin C will do just as well. The recommended daily intake of C is 60 mg per day. This is probably too low considering the extra work it may do in regenerating vitamin E. Humans, unlike other mammals cannot synthesise the vitamin C they need, and over-cooked foods are particularly depleted of vitamin C. Taking more vitamin C might not make you live longer although it might lead to a healthier old age. □

Dopamine, schizophrenia and left-brain

ALTHOUGH schizophrenia affects nearly one per cent of the population, almost nothing is known about the changes in the brain which produce the symptoms of this mental illness. However, one class of tranquilising drugs (the "neuroleptics") is especially effective in schizophrenia, and these drugs have one action in common: an ability to block the effects of the neurotransmitter dopamine in the brain. It is the response of certain groups of nerves containing dopamine which may determine the relative incidence of movement disorders, an unwanted effect of many of these antischizophrenic drugs (*New Scientist*, 6 October, p 13). These side effects involve nerve cells connecting with the striatum, which controls automatic motor function. Dopamine-containing nerves are also found in another region of the brain, the limbic system, and it is here that neuroscientists believe the malfunction responsible for the symptoms of schizophrenia may lie.

Using brain tissue obtained from schizophrenic patients after death, biochemists have searched for evidence of an overactivity of dopamine in schizophrenia. The most consistently reported finding is an increase in the number of cell membrane receptors which interact with dopamine. But this effect is not specific to the limbic system and may well be a response to the patients' drug treatment: treatment of animals with neuroleptics can increase the numbers of dopamine receptors.

Until recently, any differences in the concentrations of dopamine itself were found to be equally unspecific. In a post-mortem study reported in *Nature* (vol 305, p 527), however, Gavin Reynolds, from the Medical Research Council Brain Tissue Bank in Cambridge, has compared the amounts of dopamine in two regions of brains from schizophrenic patients. He found that the amygdala, a dopamine-rich part of the limbic system especially related to emotional behaviour, had about 70 per cent more dopamine in schizophrenics than in psychiatrically normal "control" subjects.

Not only was this increase apparent in the amygdala and not in the striatum, it could be found only in the left half of the brain. Dopamine in both regions of the right hemisphere of the schizophrenic brains was no different from normal. Interestingly, this result provides biochemical support for other evidence pointing to an abnormality of the left side of the brain in people with schizophrenia.

This is a hypothesis which was first proposed in 1969 by Pierre Flor-Henry, a psychiatrist in Edmonton, Canada, after studying the psychiatric symptoms of epilepsy of the temporal lobe (the amygdala is found in this part of the brain). He found that patients with temporal lobe epilepsy had symptoms very similar to schizophrenia when their disorder was present in the *left* side of the brain. Since then the view of schizophrenia as a malfunction of the left temporal lobe has had much support, particularly from studies using electroencephalographs (EEGs) to measure the electrical activity of the brain. □

The making of a successful swan

FOOD, one might think is the most important factor determining reproductive success in animals, but an extensive survey reveals that this is not the whole story. Dafila Scott and Mike Birkhead, working on the mute swans (*Cygnus olor*) around Oxford have discovered that the number of young raised by a pair depends more on the number of eggs laid than on any other factor (*Journal of Zoology*, vol 200, p 539).

Mute swans, like many other birds, defend territories, and it has long been an axiom of biology that animals on better quality territories should out-reproduce those on poorer ones. Scott and Birkhead decided to investigate the relationships between territory quality and breeding success among the swans of the upper Thames. Aquatic plants are an important food, so the two scientists surveyed both the amount and diversity of vegetation in the water of each pair's territory. Pasture too is important, and so is bread provided by nearby people.

In built-up areas with more houses close to the river there was more bread available but fewer plants. Bread supply was the most important variable affecting the size of clutches, those swans living close to houses laying more eggs than swans in rural areas. But with the effect of bread held constant, the amount of aquatic vegetation still had a considerable effect on clutch size.

The number of eggs a swan lays is obviously an important part of her reproductive success, but more relevant perhaps is the number of young that fledge. Surprisingly, there was no direct correlation between the number of young that survived and any of the measures of territory quality, although all the relationships were positive. But there was a correlation between number of fledglings and clutch size, which is itself related to the quality of territory.

Scott and Birkhead's results expose a possible dilemma for swans. Near houses there is an abundant supply of bread which enables the females to lay more eggs. This in turn increases the number of cygnets that will survive. In more rural areas aquatic plants are more abundant and more diverse. So the females are heavier and lay their eggs earlier. □

Fledgling survivors and parent

Why quarked niobium?

QUARKS, the supposed building blocks of matter, distinguish themselves by having electric charges that are fractions of that of an electron. Only one experiment, at Stanford University, has so far obtained evidence for sucb fractional charge, on minute balls of niobium. This presents some difficulties for theories of quarks: wby should these effects occur only in niobium? Christian Jorgensen, of the University of Geneva, has addressed this problem by asking the question "Can quarked niobium be a fission product?"

Jorgensen considers the formation of "defective nuclei"—with one quark too few—in the aftermath of the big bang (*Nature*, vol 305, p 787). At this time, as the Universe cooled, quarks would generally condense into normal nuclei—protons and neutrons—but some would survive alone. Jorgensen argued that these isolated quarks could latch onto one member of a nucleus-antinucleus pair, whicb can materialise from the vacuum (empty space) at a relatively low cost in terms of energy. Such interactions would allow a chain of reactions that could lead to beavy fissile nuclei, still deficient in quarks. And samples of niobium, a fission product, could still contain such defective nuclei. □

Of Vikings and mice

WERE THE Vikings responsible for introducing the bouse mouse into northern Britain? The idea came from R. J. Berry in 1964 to counter the old idea that these island mice arrived during the latest Ice Age when sea levels were lower. And support for Berry's bypothesis comes from a recent study of modern house mouse skeletons.

Simon Davis, researcber in Berry's laboratory at University College, London, has analysed measurements taken on over 800 mice mandibles belonging to 65 samples. These came from mainland Britain, various islands off Scotland, and Faroe. (*Journal of Zoology*, vol 199, p 521).

Davis' study shows that variation in shape is much greater among mice from different islands within Faroe than within Shetland or Orkney, and these in turn are more variously shaped than mice within mainland Britain (excluding Caithness). This is an example of what evolutionary biologists term the "founder effect".

An island population would be descended from a mere handful of individuals. Such small founder samples could differ significantly from the norm, and rapid subsequent evolution of such a small population might increase this divergence.

The suggestion therefore is that the mice in these archipelagos as well as Caithness originally came from Scandinavia—perhaps with the Vikings of the 9th and 10th centuries. □

Stardoom

BY A HAPPY stroke of serendipity, the latest *Astrophysical Journal* (vol 273, p 749) contains a report of work involving both the areas of researcb for which this year's Nobel Prize in Physics was awarded (*New Scientist*, 27 October, p 254). G. V. Bicknell and R. A. Gingold, of the Australian National University, describe bow stars squeezed by the tidal influence of a large black hole detonate explosively.

We are used to the idea of stars being torn apart and disrupted as they are swallowed by a black bole. But the latest computer simulations show that the actual fate of a star passing near a bole with a mass of about a bundred thousand Suns is to be stretched by tides in the direction of its orbit and simultaneously squeezed in a direction perpendicular to the orbital plane. This compression causes shock heating of the star material, triggering "burning" of carbon, nitrogen and oxygen, blasting the star apart. □

MONITOR

Linus Pauling discovers a new chemical bond

Lionel Milgrom

A NEW TYPE of chemical bond has been discovered that could mimic, for small molecules, the kind of bonding thought to exist in bulk metals. And who better to announce this discovery than the grand-daddy of modern chemical bonding theory and double Nobel Laureate, Professor Linus Pauling.

The new bond is found between two tin atoms in a molecule also containing carbon and silicon. But Pauling thinks that this type of bond may not be so rare. It could be found in compounds containing elements like germanium, gallium, indium, and thallium.

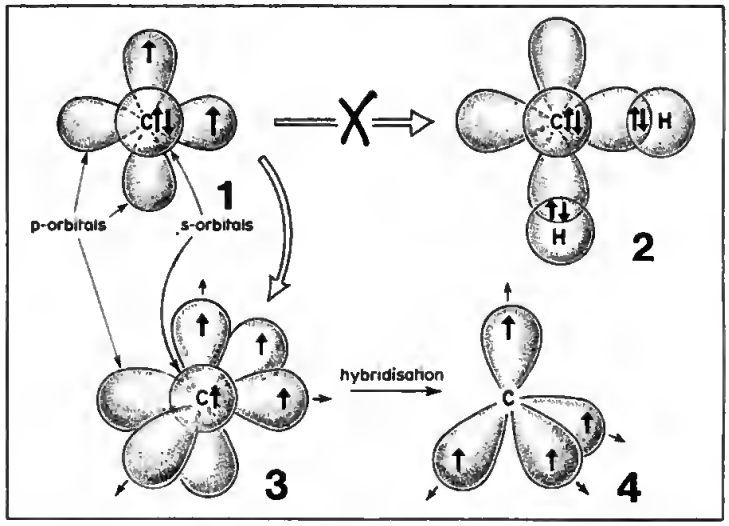
In neutral atoms, the positively charged nucleus is surrounded and balanced by negatively charged electron-clouds. Chemical bonds are formed by interactions between the outer electron clouds of different atoms. Covalent bonds result when electrons are shared between atoms. In covalent bonding, the shape and orientation of these electron clouds, to a large extent, determines the geometry of the molecules that are formed.

Take carbon, for example. It has four outer electrons for bonding. In carbon's lowest energy state, two of these electrons exist as a spherical cloud called an s-orbital. The other two electrons are two dumb-bell-shaped clouds (p-orbitals), set at right-angles to each other, and pointing away from the nucleus. In chemical shorthand, this configuration of electrons is written as s^2p^2. (Figure 1).

The p-electrons have slightly more energy than the s-electrons. Therefore, one would expect carbon to be divalent (use only two electrons for chemical bonding) and to form L-shaped molecules with other atoms (Figure 2). In fact, carbon is tetravalent, using all four electrons to form tetrahedral-, planar-, and linear-shaped molecules. Chemists get round this apparent contradiction by invoking the concept of hybridisation.

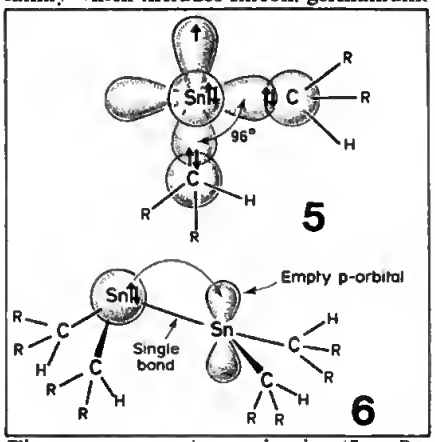
Put simply, hybridisation is the mathematical equivalent of scrambling eggs. Imagine you had one duck egg and three chicken eggs to share *equally* between four people. How would you do it? The simple answer is to break all the eggs into a bowl, beat them together, and cook. The scrambled eggs are then divided equally into four portions. Each person now has a quarter-share in four scrambled eggs, containing one part duck and three parts chicken eggs. For eggs, read electrons.

To make a tetrahedrally-shaped carbon atom, an s-electron is first promoted into a p-orbital at right-angles to the other two. (The electron configuration is now written as sp^3) (Figure 3). Then all the s- and p-electrons are quantum-mechanically scrambled. The result is four one-electron sp^3 hybridised orbitals, of equal energy, pointing to the corners of a regular tetrahedron (Figure 4). Each oribtal has one part s-character and three parts p-character. The carbon atom is now in good shape to form single bonds with other atoms, for example hydrogen, to make methane. Although there is an energetic price to pay for hybridisation (an s-electron has to be promoted up to a p-orbital), this is more than compensated by the energy released when the carbon atom bonds.



Carbon in its electronic ground state s^2p^2 (1) should form divalent, L-shaped molecules (2). It does not. Instead, an s-electron is promoted into a vacant p-orbital (3) and then all the s-and p-wave functions are hybridised to give four sp^3-hybrid orbitals (4)

Now, carbon is the first element in a family which includes silicon, germanium, tin and lead. These elements constitute group IV of the periodic table. As the series is descended, there is a tendency for the atoms of each element to show increasing divalent character.



The monomer tin molecule (5). R= $-Si(CH_3)_3$ and the dimer molecule (6) showing the tin-tin bond and the origin of its partial double bond character

What is happening is that the energy required by hybridisation (to promote an s-electron into a p-orbital) is not being so well accounted for by the energy released during bond formation. For tin, the divalent state is about as stable as the tetravalent form at ordinary temperatures.

In the molecule containing tin, carbon and silicon, its structure in the gas phase shows tin forming two single bonds to carbon atoms (Figure 5). The C-Sn-C bond angle is 96°, which is that expected for divalent tin. In the solid state, this molecule should either maintain its structure or pair with itself (dimerise) to form a tin-tin double bond in which the tin atoms are tetravalent. If the latter were the case, then the new dimer molecule should be planar (like ethylene) about its double-bond. This does not happen.

A tin-tin bond is formed but the new dimer molecule is far from flat. It is pyramidally-shaped about each tin atom. The tin-tin bond length is much greater than a double-bond but too small to be a single one. In fact, the tin atoms are apparently not behaving at all like normal divalent or tetravalent tin atoms.

Pauling rationalises this behaviour like this. Suppose one tin atom is in its electronic ground-state, s^2p^2. The second tin atom is sp^2-hybridised, leaving out one p-electron. This is then transferred to the first tin atom making it s^2p^3 and negatively charged. A positive charge is left on the second tin atom which now has an electron configuration of sp^2. The first, negatively charged tin forms three bonds using its three unhybridised p-orbitals. The positively charged tin uses its three hybridised sp^2 orbitals to form bonds. This leaves two s-electrons (lone-pair) on the negatively charged tin which can be transferred back to the other tin atom's now-empty p-orbital. Once the switch has been made, the atoms have reversed their "identities". The lone-pair can now switch back again. In other words, the lone pair resonates between the two tin atoms. The tin-tin bond is somewhere between a single and a double bond in character. It helps to stabilise the molecule with about 12 per cent of the energy of a single bond (Figure 6).

What is interesting here is that this new bond mirrors for two atoms the kind of bonding that gives bulk metals their characteristic properties (eg, electrical conductivity). In metals, atoms are bonded together into lattice structures awash in a "sea" of resonating electrons. These are virtually free to wander through the lattice. The tin-tin bond in this dimer is a true metallic fragment whereas in distannane (Sn_2H_6, the tin analogue of ethane, C_2H_6) it is not. Similar behaviour is predicted in molecules of germanium, gallium, indium, and thallium. (*Proceedings of the National Academy of Sciences*, vol 80, p 3871). □

TECHNOLOGY

False alarms jam rescue satellites

Christopher Joyce, Washington DC

THE CAPTAIN and two crewmen of the 17-metre trimaran Gonzo probably would have perished 500 kilometres off the coast of Massachusetts on 21 October last year, had it not been for a Soviet spacecraft. Capsized in 8-metre high seas, the sailing boat's radio beacon transmitted a distress signal to a Soviet satellite, which fixed the boat's position to within a few kilometres and brought rescuers to the sailors' aid before the elements claimed them.

The new satellite system is known as SARSAT (short for search and rescue satellite-aided tracking). However the satellites are being swamped by false alarms which threaten to prevent genuine calls from getting through.

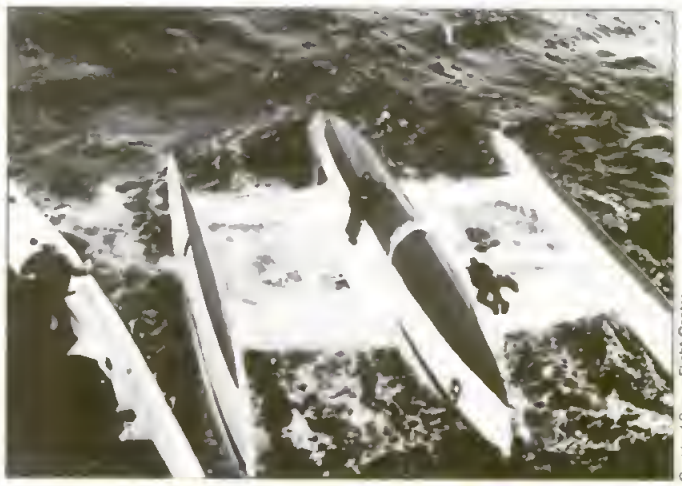
The SARSAT system has two Soviet and one American satellites, which orbit the world in a low polar orbit. They provide an electronic safety net for aircraft's pilots and sailors.

The hitch in the £24 million system is, says one senior US Air Force official, a "national disgrace" that could cost lives needlessly. Although the three satellites are working flawlessly, the beacons carried by pilots and sailors are anachronisms. The result is that 97 out of every 100 signals detected from North America are false alarms.

The most frequent causes of false alarms are the beacons carried aboard America's 200 000 private planes. Every plane must carry an emergency locator transmitter (ELT). Ships more than 32 kilometres offshore must carry a similar device.

If a plane crashes, vibrations activate the ELT to transmit an easily recognisable signal on an international distress frequency, 121·5 MHz. The ship's radio beacons are switched on manually. Before SARSAT, commercial flights and airports monitored this frequency as a matter of course. But only signals within a few hundred kilometres could be picked up, and without much accuracy. Remote areas were often out of range.

The two Soviet satellites were launched in 1982 and 1983. The US added its satellite last spring. The system covers the whole planet, and, with a planned fourth satellite, a downed pilot could expect a distress signal to be picked up within three hours on average—a comforting thought as only 10 per cent survive more than 48 hours.



Goddard Space Flight Center

Just in time—for the crew of the Gonzo

The ELTs, however, have a long history of inadequacy. They operate on a "gravity switch" that is sensitive to certain vibrations. Research by engineers at the National Aeronautics and Space Administration (NASA) shows that crashes normally create a low-frequency pulse of something like 10 Hz. The switches, however, are often activated by higher frequency vibrations, like those set off when a pilot lands hard, or slams the cockpit door. Corroding batteries also set off the switches, or pilots throw them away, only to be found by rescuers years later in a rubbish tip or attic.

Between 1975 and 1980, the rate of false alarms topped 90 per cent, and each year fewer pilots reported distress signals; they simply didn't believe them. When the SARSAT system swung into action, the number of reports rocketed, because the unmanned satellites are more sensitive, and report everything they hear. Yet the rate of false alarms remains the same. Thus, says Lieutenant Colonel William Clark, the US Air Force's director of search and rescue operations, the satellites are a "mixed blessing", sending teams out on fruitless searches more often than ever.

NASA has, in fact developed ELTs that are less vulnerable to inadvertant jolts. Other government agencies are persuading pilots to install monitors that will actuate an alarm or a light when their ELTs switch on. Current models transmit unbeknown to their owners.

NASA is also testing ELTs that will transmit coded signals at 406 MHz, which the American satellites can receive. These signals carry a signature of their source, so that a potential false alarm can be checked by phone, and can also be pinpointed within two to five kilometres.

In the meantime, the air force is now checking each distress signal with a second pass of a satellite. Responding to the first signal, says Clark, "almost broke our backs". Rescuers are thus held back another two to eight hours, and that could be costing lives.

● Intelsat, the international organisation that operates communications satellites, is drawing up plans for a huge new spacecraft that could enter orbit in 2010. The satellite would have a mass of 50 tonnes, more than 10 times bigger than Intelsat's generation of vehicles, the Intelsat VI series, that will enter orbit in 1986. The new vehicle, called Intelsat 1A-1, would measure 236 by 245 metres, the size of a couple of soccer pitches. It would relay up to 5 million two-way telephone conversations and hundreds of TV programmes. □

Luxembourg plans business satellite

THE TINY Grand Duchy of Luxembourg is threatening to upset the plans of Europe's satellite communications giants. Luxembourg says it will launch a satellite to channel data between businesses. The system will compete with other European satellites.

These include a series of at least three European Communications Satellites owned jointly by Western Europe's telecommunications administrations. Other satellites include France's Telecom-1, to be launched next year, Britain's Unisat and the German DFS satellite, both of which should enter orbit in 1986.

The Luxembourgers have disclosed few of their plans for the satellite. The scheme is being handled by the prime minister's office which is even keeping Luxembourg's telecommunications authority in the dark about the system. European sources suggest that Luxembourg is aiming at a 1985 launch date, although this is unrealistic unless it has started building the satellite already and found a launcher.

An early launch could give Luxembourg a lead in business satellite services. The country's plans for a TV broadcasting satellite have been thwarted for financial or political reasons. Luxembourg is entitled to an orbital position and satellite "footprint", that would cover a huge part of Western Europe. The country's own banking population would be a big customer for business services, and Luxembourg could always use the satellite to relay television transmissions, as the other business satellite operators, such as the British firms that will launch Unisat, are planning to do.

Luxembourg is annoyed that it has not been allocated transponders on the European Communication Satellites. These have gone to nine countries but Luxembourg has been left out on what seems to be a law of the jungle principle: Luxembourg is small, other applicants were bigger. French and German pressure has also discouraged any attempts by Luxembourg to launch its own TV satellite.

Industry experts are split over whether to take the Luxembourg plan seriously. Some believe it is a ploy to achieve a better negotiating position on the issue of TV satellites. □

Cell radio set to multiply

RADIOPHONES could become more common if research at Bath University reduces the frequency band needed to transmit speech.

The researchers at Bath are trying to cram more speech signals into a small band of frequencies with a technique called signal sideband modulation (SSB). The technique could be used in Britain's new system of cellular radio, due to start in 1985.

The idea of mobile radiophones is as old as radio, and most countries already have systems in commercial operation. A transmitter with a range of around 50 kilometres covers a city. The number of subscribers is limited because there are not enough radio frequencies to go around. The cellular approach was first proposed by Bell Laboratories in the US in 1947, but the technology needed to make it work was not then available.

In a cellular system, many low-power transmitters are used. Each transmitter serves a small cell area, a few kilometres wide. By making all the areas hexagonal, it is possible to cover an unlimited area of town and country with a honeycomb of cells. No two adjacent cells use the same transmission frequency, so they cannot interfere with each other. In this way only a few frequencies are needed.

The difficult part is to make a computer system which will automatically hand over the signals from one transmitter to another. The British system will be an improved version of the system originally developed by Bell Laboratories for a trial in Chicago.

The UK's base stations, with transmitters and computer control, will be run by two competing groups, Racal and a consortium of British Telecom and Securicor. Both groups will use the same technology, to create a unified standard.

Anyone will be able to make and sell the mobile transceivers as long as they stick to the standard approved by the British government. Unfortunately, the British Standards Institution has yet to specify a standard for mobile hardware.

The rival cellular radio groups were cagey about technical details until the government confirmed their operating licences. Now they are talking more freely. Each cell will have a maximum of 39 channels. One channel, dedicated to digital data, sets up the calls by paging the mobile users and assigning the other channels for speech. These speech channels also carry some digital data signals, in gaps between words, to control the handover from one frequency to another as a mobile crosses into the next cell.

The long-term problem, which interests Bath University, is capacity. The speech is transmitted as analogue waves by frequency modulation, and 25 kHz bandwidth is the minimum for acceptable quality. The government is unlikely to make any more frequencies available, so if the radiophone system is to expand it must be able to cram intelligible speech into narrower channels.

There are two ways of doing this. These either use SSB or digitally encode the analogue speech before transmission. It would even be possible to combine both, by transmitting digital speech by SSB. But until recently SSB was unusable at the high frequencies, of around 900 MHz, allocated for cellular radio. This is because no carrier frequency is transmitted with SSB, so it is difficult to hold the receiver on tune. Bath University believes it has licked most of the SSB problems, by transmitting a pilot tone to lock onto the right frequency. With SSB the bandwidth can be reduced to 5 kHz.

Digital transmission on narrow bandwidths relies on breaking down the speech into a crude code which is then used to trigger a speech generator at the receiver. □

Crutches within wheels; Salford University's standing and sitting wheelchair

Stand on your own two wheels

DISABLED people for whom walking is difficult may find life easier as a result of an invention by engineers at the University of Salford. Workers at the university's Department of Orthopaedic Mechanics have produced a combined wheelchair and standing frame that eases people from a sitting to an upright position. A special mechanism in the wheelchair pushes up the seat with a ram powered by tiny batteries.

This step forward follows years of work at the department on improving a device called the swivel walker, a frame for paraplegics that supports their bodies while they move about. With the device, the disabled person walks in a set of shuffling movements. The person does this by swaying the upper part of his or her body from side to side.

Engineers at Salford reasoned that paraplegics could attain greater mobility if the swivel walker were linked to a wheelchair. The trick was to engineer both devices so that a person sitting in a wheelchair, with the swivel walker bent at the knees, can rise comfortably to the standing position. According to the university's estimates, in full production the adapted swivel walker and wheelchair would cost about £1150. The university is looking for a business partner that would turn out the mechanisms as a commercial product. □

Businesses group together to aid innovation

A GROUP of the largest companies in Britain has set up a new information exchange to encourage innovation in companies.

Sir Denning Pearson, the former chairman of Rolls-Royce, said at the launch of the Centre for Innovation in Industry (CII) that British inventions are being exploited abroad but not at home.

The irony in Sir Denning's praise is that the country imports the most basic goods, such as towel racks and kitchen utensils, because the home-produced versions are so badly designed. It never seems to sink in that it is as easy to produce well-designed products.

The CII will provide members with independent information on innovation, from the concept to marketing. It is an independent body owned by the businesses and organisations that belong to it. CII's object is to help its members who need to find, finance and manufacture new products.

The 48 founding members include six banks and many "blue-chip" companies. The firms include Boots, BP, Rolls-Royce, Tube Investments, ICI, Hoover and Rowntree Mackintosh. One of CII's tools will be a frequently updated directory.

This type of service has long been available in the US. CII's directory has a depth and breadth that impressed journalists at the launch who are used to seeking out and dealing with such information.

Other services will include advice on finance, a new-product databank (it already contains thousands), explanations of how to make best use of the 20 or more technology exchange fairs and help with licensing.

"CII holds out the promise to small and medium firms, at small cost, the opportunity to ensure their products' competitiveness in design and the use of the most appropriate technology available," said Sir Denning who was chairman of the centre's steering committee. "We have the world's sources of new innovations, new ideas and new devices."

Many fingers have been wagged at British industry's lack of innovation and competitiveness. Brian Locke, a director of the new centre and a partner in Cadogan Consultants, said, "Markets are the most important. We no longer manufacture for a captive, national market; all markets are becoming international." □

Japan is slow to lift off into space

GOVERNMENT agencies in Japan are doing their best to reduce their reliance on foreigners for satellite technology. But the country is having far less success in developing its own rockets to lift the satellites into space.

In a recent order for a new generation of communications satellites, Japan's Science and Technology Agency placed its faith in space hardware that Mitsubishi Electric Corporation is to develop. The company is to build two 550 kg spacecraft, due to be launched in 1987.

Mitsubishi's satellite technology emphasises Japanese-made hardware. The company won the order in the face of competition from NEC, another Japanese company, which bases its designs on technology developed by the US's Hughes Aircraft.

Kimio Fukushima, director of the agency's Research Coordination Bureau, said: "We have no objection to buying components from overseas. But it is pointless to go on paying for foreign technology in sealed black boxes."

In fact, NEC's bid never stood much hope of success. Mitsubishi is the government's designated satellite builder, and its design was cheaper.

Furthermore, according to Mitsubishi, its technology will produce less complex and lighter satellites than anything that Hughes Aircraft could provide. The space vehicles will be built from plastic reinforced by carbon fibre. This is about half as heavy as the conventional aluminium alloy.

The solar panels are made from gallium arsenide, instead of silicon. The new material should produce more power from a given amount of radiation from the Sun, reducing the area of panels that the satellites need.

The tussle over the contract for the communications vehicles highlights the competition between Japan's satellite builders, which, together with Mitsubishi and NEC, include Toshiba. Toshiba's main job is to build broadcasting satellites. The three firms may join forces in work on Japan's remote-sensing vehicle, ERS-1, due to go aloft in 1987. The craft will scan the Earth with microwaves that "see" through clouds.

The remote-sensing satellite will be lifted into space by the H-1, the latest rocket under development at Japan's National Space Development Agency. Every piece of the rocket will be made in Japan. But the technology was originally developed in the US for the Thor intermediate-range missile.

With a new second stage powered by liquid oxygen and liquid hydrogen, the H-1 should be ready in two years and meet Japan's needs for the next 10 years, says the country's space agency.

The H-1 is positively puny. It will put into orbit payloads of no more than 800 kg. The rocket's successor, the H-2, is still on the drawing board. The vehicle, which will lift satellites of more than 1 tonne, which is about the mass of many of today's communications satellites, will not be ready until the mid-1990s at the earliest.

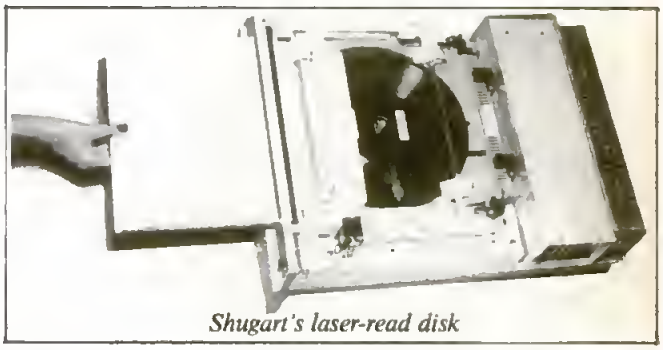
NTT, Japan's telecommunications authority, is grumbling at the slow progress in developing home-grown rockets. The authority has big plans for communications satellites, but is resigned to launching them with foreign vehicles, probably the US's space shuttle. □

New light for archives

LASER-READ disks may have failed to impress the domestic video and hi-fi market, but they could prove invaluable for storing computer archives.

Next year Shugart, an American company which pioneered the floppy disk for computers, plans to introduce a 30 cm optical disk in partnership with the French firm Thomson CSF. One side of the disk can hold 1000 million bytes of information, equivalent to 400 000 pages of text. The disk, a player and interfaces for linking it with a computer will cost between £8000 and £10 000.

Meanwhile, Storage Technology, a company that makes large magnetic disks, has produced an optical disk system with four times the capacity of the Shugart disk at a price of £140 000. This recorder will work with IBM mainframes.



Shugart's laser-read disk

Philips also has a digital optical recorder which has yet to go on general sale. The company's recorder is part of a system for creating archives. Called Megadoc, it costs £250 000 and was developed in partnership with Control Data, the computer company. Unlike home recorders, all these systems can record as well as play back disks. Their laser beams are "turned up" to burn pits inside the disks and then "turned down" so that the holes, each representing one bit of data, can be scanned.

Computers require much higher quality reproduction than TV sets or stereos. A piece of lost information in a film would probably go unnoticed, but in computer data it could make nonsense of the computer's results. While a TV player can tolerate one error in every 10^6 bits stored, a computer demands an error rate of 1 in 10^{12}, or better.

With optical systems for computers, there is one drawback. It is difficult to alter the information that they store. So the systems can create only archives that do not need to be changed. At present most of these archives are stored on magnetic tape. The information has to be re-recorded every two years as the magnetic fields on separate sections of tape begin to interfere with one another. Optical disks have a life of at least 10 years.

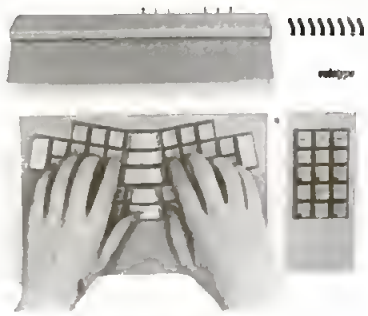
So far, only the Japanese firm Matsushita claims to have cracked the problem of producing an optical disk which can be used time and again, in the way that magnetic disk or tape can be. But the company has yet to demonstrate a product. □

Typewriter breaks speed limit

A NEW kind of typewriter, the Velotype, has broken the world record for typing speeds, according to the Dutch company which makes the machine.

Special Systems Industry claims typing speeds of up to 1000 characters per minute. The world record for a conventional typewriter is 683 characters per minute.

The secret behind these high speeds is that the Velotype has borrowed the stenographic trick of typing in syllables rather than single characters.



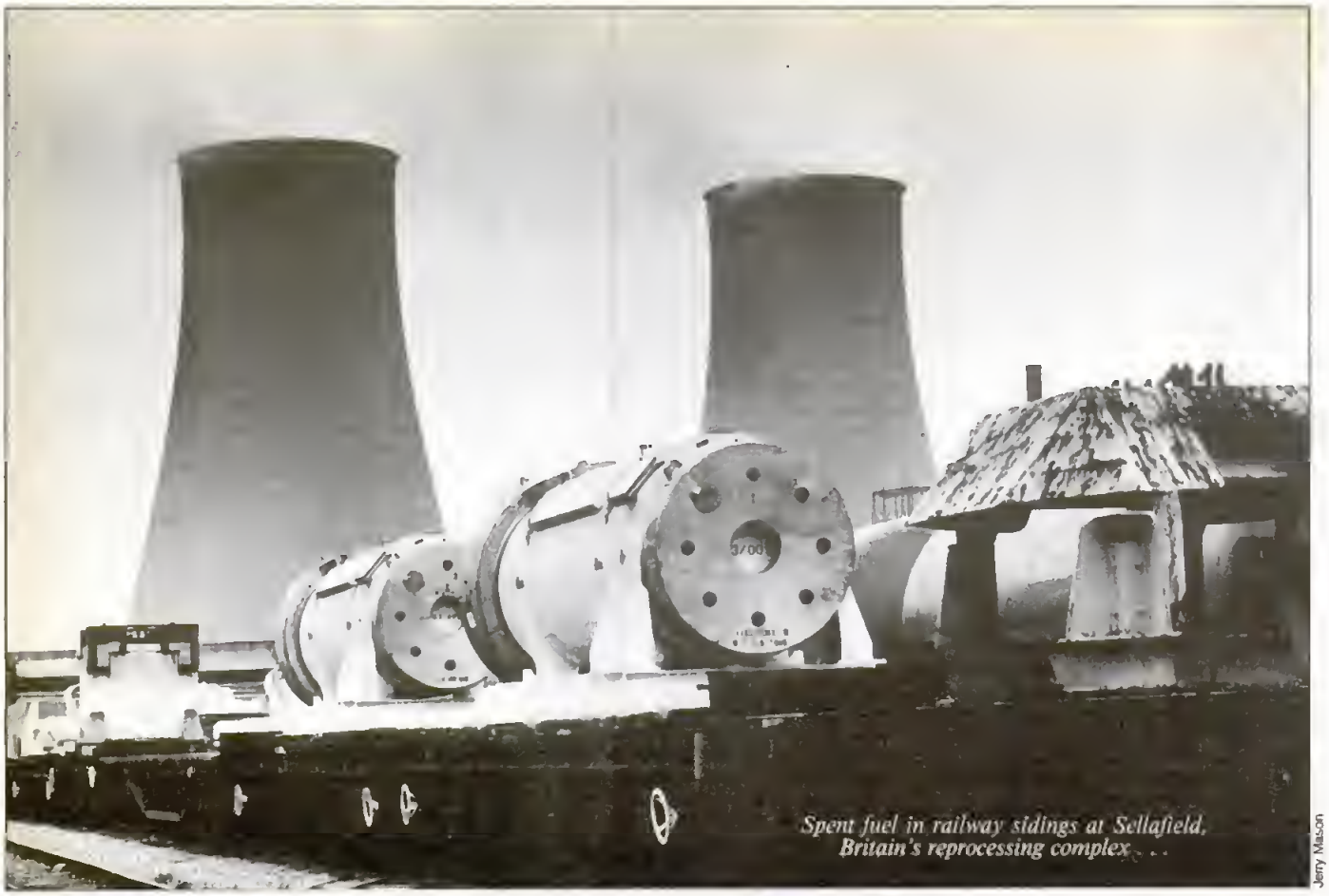
A handful of keys

The keyboard is arranged to minimise finger movements and balance the work load between the two hands. It has three "fields". The left field comprises mainly the consonants at the beginning of a syllable, and the right field those at the end. The centre field consists of vowels. Most common consonants are found in both the left and right fields.

The Velotype incorporates a microprocessor to prevent the typist transposing letters at high speeds. This translates an input of ". . . ign" as ". . . ing". The mechanism greatly increases typing speeds by reducing the need for typists to worry about mistakes.

The claims made for the Velotype are supported by a trial carried out by the Dutch Stenography, Typewriting and Office Practice Association. This found that a typist could attain a given speed on the Velotype in a quarter of the time it takes to reach the speed on a conventional machine.

However, the machine still has to break the stranglehold of the conventional QWERTY keyboard. Special Systems Industry has concluded an agreement with the Dutch firms Philips and AES to allow the Velotype to be offered as an alternative keyboard on their word processors. □



Spent fuel in railway sidings at Sellafield, Britain's reprocessing complex . . .

Jerry Mason

Not in my backyard!

Nobody wants nuclear waste in their backyard or off their coastline. The British government knows that better than anyone. But how real are the fears of the objectors? And can we really guess what risks future generations will run from radioactive wastes buried today?

Fred Pearce

ON 10 July this year, angry Spaniards in the Atlantic province of Galicia stormed the office of the local British consul. Others travelled to Gibraltar and chained themselves to the entrance of the Governor's residence. Meanwhile, Belgian militants demonstrated in Brussels and the Portuguese government handed over a letter of protest to British officials in Lisbon.

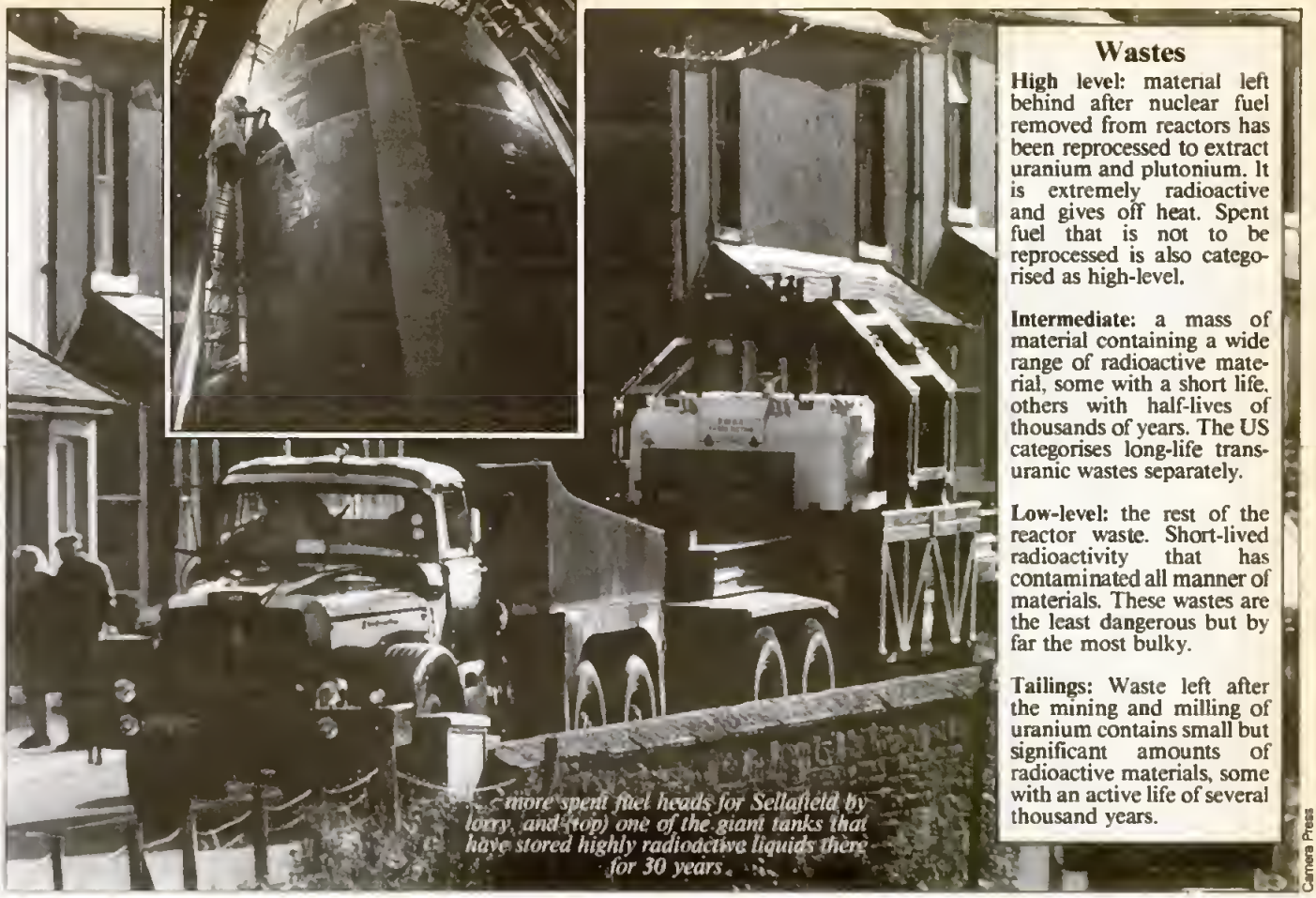
The reason? Britain had announced that it intended to proceed with its annual dumping of waste, containing small amounts of radioactivity, into the ocean 800 kilometres from the northwest tip of Spain. The waste, then still sitting in railway sidings in Oxfordshire, was cased in concrete. It was to have been dumped at a point where the water is more than 4 km deep. The opposition from other nations and the seamen's union in Britain was so strong that the waste never left Oxfordshire.

The notion that, even in the long term, this waste could harm the people of Spain was absurd. Campaigners against the dump, such as Greenpeace, privately admitted as much. They objected to the principle. Many Spaniards feared for their lives. One problem with the growing debate about nuclear waste is retaining a sense of proportion.

Sea-dumping is one relatively minor aspect of a growing industry in handling and disposing of radioactive wastes. Everywhere public opposition is increasing. Back on land, environmentalists and local councillors in Britain are girding themselves for a battle over two new burial sites for disposing of a wide range of wastes known as low- and intermediate-level radioactive wastes (see panel opposite). The dumps are proposed for a former anhydrite mine in Billingham and trenches dug into Bedfordshire clay (last issue, p 248).

Objectors hope to repeat their victory of two years ago. Then they forced ministers to abandon drilling in several parts of Britain to find rocks that are suitable for the disposal of high-level radioactive waste. Ministers were so alarmed at the opposition that they announced that no decision on the disposal of high-level wastes need be taken for another 50 years. The waste would stay in tanks at Sellafield in Cumbria, they said, and all drilling in Britain was dropped.

Across the Western world a similar picture emerges. Earlier this year, Japan abandoned a scheme to drop 92 million litres of low-level waste 600 km off the uninhabited Maug Island in the Pacific because of opposition from nearby islanders in the Marianas chain. Instead the waste will go into store until a dump on land is ready. But the proposed site for the new dump is on the densely populated Japanese island of Hokkaido, where the local socialist administration will oppose the plan. In France last year, planners turned down a proposal to bury waste at St-Priest-la-Prugne. The authorities will announce new sites this winter. The energy minister says that he will offer cheap electricity and other inducements to reluctant neighbours of any dumps.



BNFL

Camera Press

... more spent fuel heads for Sellafield by lorry, and (top) one of the giant tanks that have stored highly radioactive liquids there for 30 years.

Wastes

High level: material left behind after nuclear fuel removed from reactors has been reprocessed to extract uranium and plutonium. It is extremely radioactive and gives off heat. Spent fuel that is not to be reprocessed is also categorised as high-level.

Intermediate: a mass of material containing a wide range of radioactive material, some with a short life, others with half-lives of thousands of years. The US categorises long-life transuranic wastes separately.

Low-level: the rest of the reactor waste. Short-lived radioactivity that has contaminated all manner of materials. These wastes are the least dangerous but by far the most bulky.

Tailings: Waste left after the mining and milling of uranium contains small but significant amounts of radioactive materials, some with an active life of several thousand years.

Small wonder that nuclear engineers around the world today talk as much about the public acceptibility of radioactive waste as they do about the technology of disposal. Many seriously wonder whether public opposition may eventually force the abandonment of the nuclear adventure. This has happened already in Sweden.

Radioactive waste arises in many forms. Huge amounts of tailings sit next to abandoned uranium mines in North America and Australia. Discarded isotopes from hospitals slowly decay in municipal tips. Old nuclear submarines rust in naval yards. And growing volumes of highly radioactive liquids sit in tanks at reprocessing plants.

Some wastes decay and lose their potential to cause cancers and genetic defects within a few years. Others will be dangerous for millennia. An increasing amount of waste, from the least to the most radioactive, is held in silos and tanks awaiting disposal. This backlog of waste is a growing technical burden for the nuclear industry and is a public relations timebomb. The International Atomic Energy Agency estimates that by 1990 some 500 nuclear power stations will be in operation around the world—double today's tally. That number will double again by 2000, by which time they will have produced 300 000 tonnes of spent fuel, most of which will be sitting in stores, and several million tonnes of other wastes—some of which will not be safe for thousands of years.

There are two crucial issues facing the planners of disposal of the world's growing stockpile of radioactive wastes. First is public fear and opposition to all kinds of radioactive waste. Will it become so strong that the political backing for the nuclear industry will be destroyed? Or might it encourage the continued storing of waste and the postponement of decisions about final disposal? The second issue is the long-term safety of buried waste. Most countries agree that no future generation should be presented with a greater risk from our buried waste than the present one. But how certain can we be about the integrity of containment over thousands of years—and about the kind of societies that will inhabit this planet by then?

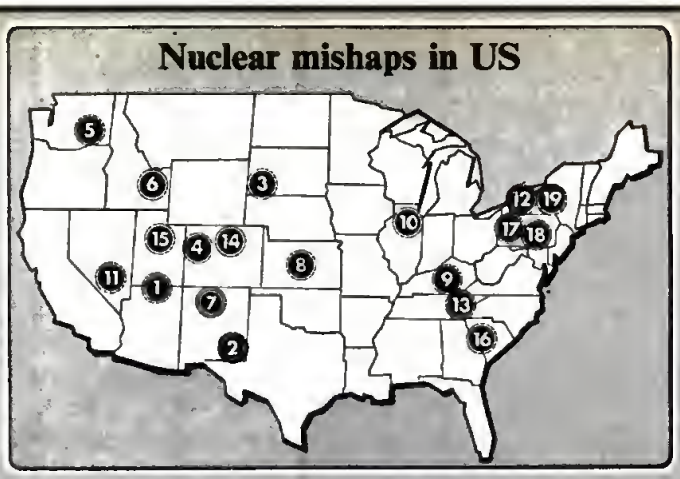
A considerable amount of research has been undertaken in the past decade to improve the technology of waste disposal. *New Scientist* has chronicled much of this work. But hazards caused by bad practices in the early, principally military, days of the nuclear industry still abound (see panel on p 348 for examples in the US). And the real risks to future generations are almost impossible to calculate.

Uranium, the basic fuel for nuclear power, is mined all over the world. Even Britain has untapped reserves in the Orkney Islands. Wherever uranium is mined, huge piles of waste tailings, often containing quite large amounts of radioactive material, build up. A recent inventory put the total scattered across the US at 100 million m^3. In Canada there will be 300 million tonnes by 2000. The waste has polluted the Elliot and Great Bear lakes in Canada. In Australia, tailings from the Rum Jungle mine have been scattered across a wide area south of Darwin, ending up in local rivers.

Robert Pohl, Professor of Physics at Cornell University in the US, described the risks from uranium tailings in a paper published in *Physics Today* last year. "On top of [an average] tailings pile, a person will be exposed to a whole-body gamma-ray dose rate of 12 rems per year, or more than twice the maximum permissible dose for occupational exposure. If a building were constructed on a tailings pile with a basement dug into it, lung dose rates of 30 rems per year would be expected . . . people living in this house would be twice as likely to die from lung cancer as they otherwise would."

Radioactivity can be carried by wind or water from unprotected piles of tailings. According to an investigation by the Department of Energy in the US, the rate of lung cancer within 1·5 km of a tailings pile is likely to increase by 14 per cent. The General Accounting Office in Washington esti-

Nuclear mishaps in US



THE US is the home of most of the West's nuclear wastes. Its vast weapons and civil power programmes have built up an impressive backlog of wastes and attempts to clear it have been dogged by false starts and pollution incidents. The map shows some principal sites and hazards.

1 Cane Valley, Utah and Arizona. Uranium tailings contamination.

2 Carlsbad, New Mexico. Site for a research project into deep disposal of high-level defence wastes.

3 Edgement, South Dakota. Tailings contamination of buildings.

4 Grand Junction, Colorado. Radioactive uranium tailings used as buildings material. 600 buildings are to be decontaminated.

5 Hanford, Washington. 200 000 m^3 of high-level wastes, from 30 years' reprocessing of defence fuel, sits in 149 corroding tanks with single walls. The liquids are slowly being pumped to new double-walled tanks. Leaks from land dumps containing 500 000 m^3 of solid wastes and 130 million litres of liquids have contaminated soil. The droppings and carcases of local rabbits are radioactive.

6 Idaho Falls, Idaho. Store for two-thirds of the long-lived transuranic wastes from defence activities. Land dump contains 57 000 m^3 of transuranic waste that may have to be exhumed. Also stores in stainless steel bins 25 000 m^3 of high-level liquids from reprocessing.

7 Los Alamos, New Mexico. Land dump contains 11 500 m^3 of transuranic wastes which are "subject to possible remedial action".

8 Lyons, Kansas. Site of the US's first attempt to build an underground dump for high-level wastes. The salt beds were peppered with old mine shafts, however, and the project was abandoned in 1972.

9 Maxey Flats, Kentucky. Commercial dump, shut down in 1979 after leaks appeared in the clay lining of the trenches.

10 Mound City, Ohio. Plutonium processing plant will cost $64 million to clean up.

11 Nevada test site for atomic weapons. Transuranic wastes produced during test explosions "will remain interred since retrieval is not practical".

12 Niagara Falls, New York. Commercial waste store has contaminated soils in the surrounding neighbourhood.

13 Oak Ridge, Tennessee. 6200 m^3 of transuranics buried in dump for low-level waste.

14 Rocky Flats weapons plant, Colorado. Several kilograms of plutonium leaked from this site over several years. Contaminated soil is now being scraped up and taken to Idaho Falls.

15 Salt Lake City, Utah. Tailings contamination.

16 Savannah River, South Carolina. Reprocessing centre for defence industry. Underground tanks (many of them with single walls) store 250 000 m^3 of high-level liquids. Land dump holds transuranic wastes which may have to be exhumed.

17 Shippingport, Pennsylvania. A naval nuclear reactor will cost $67 million to dismantle.

18 Three Mile Island, Pennsylvania. The world's most famous nuclear accident in 1979 partially melted the reactor core. Dismantling of the core begins next year. All manner of wastes are likely to emerge.

19 West Valley, New York. Commercial reprocessing plant shut in 1972 leaving 3 million litres of high-level liquids in tanks. The next-door land dump flooded in the mid-1970s and is closed. □

mates that the decontamination of 22 tailings piles in the US could prevent 46 deaths from cancer in the next 25 years and hundreds more in the next century. A decontamination programme is now under way. It began work this year at Grand Junction, Colorado, where local builders had used sandy tailings in the foundations of houses for 15 years. The bill for cleaning up more than 600 buildings in the city will be $17 million. The traces of uranium in the tailings used at Grand Junction would have been enough to power one 100-Megawatt power station for six months.

Mill tailings have the potential to cause cancer for many thousands of years. The half-life of one important constituent, thorium-230, is 80 000 years. In many places the chance of future generations digging up the tailings is considerable. Even if they do not, what if the water table rises, saturating the tailings and releasing radioactivity into local well waters? Pohl estimates that "the amount of radium contained in the mill tailings produced in providing the fuel for one large reactor for one year could contaminate 8 million cubic metres of water to the maximum permissible concentration for the general population". There are methods of ensuring that this does not happen. The tailings could be mixed with a binder and buried in deep mines—the solution favoured for long-lived wastes from nuclear power stations. Or thorium and radium could be extracted chemically. But this is too expensive, says the nuclear industry. At one mine in Cluff Lake, Saskatchewan, in Canada, tailings are stored in concrete bunkers. But this is rare. As the Canadian government itself admits: "There is not sufficient knowledge at the present to confidently project the possible detriment to man and the environment from uranium tailings."

In the early days of the nuclear industry, only two types of radioactive waste from reactors were recognised: high-level wastes and the rest. There was little concern over the radioactive lifespan of these "other" wastes, and most were buried, with little ceremony, in shallow trenches in the earth. The long-term risks from such dumps were summarised by the French Institute of Nuclear Protection recently: "It is impossible to rule out the possibility that after a few centuries, leaktightness of clay cover [at such dumps] may be reduced and that the ageing of the coating will increase the rate of leaching. Since administrative inspection will have lapsed... building works will damage all or part of the storage whose concrete structure may well have lost its mechanical strength." The institute was concerned about the danger from long-lived waste buried at the French waste complex at Cap la Hague.

In the US, before 1970, one million m^3 of wastes, containing plutonium and similar long-lived radioactive materials, were dumped in shallow trenches at 13 tips, which are now regarded as suitable only for wastes with short active lives. According to the American authorities, much of it may now have to be dug up and put back into store until new safer burial grounds can be found. Britain has decided to bury similar wastes in an abandoned mine several hundred metres underground at Billingham, Cleveland (see panel opposite for a detailed breakdown of disposal routes for British wastes).

A basic rule for the management of shallow burial sites is that the water table should not rise and threaten to swamp the dump with water. This creates special problems in wet countries. In May, Balu Mohan from the Bhabha Atomic Research Centre in Bombay told a conference organised by the IAEA in Seattle about two dumps on the west coast of India at Tarapur and Bombay. "At the peak of the monsoon season the sub-surface water level may reach within a few centimetres of the surface," he reported. There was frequent flooding of the trenches because faulty seals let the monsoon rains in. Other hazards at Indian dumps included earthquakes and fires, he said.

Worse may have happened at a nuclear waste site in the ▶

British nuclear waste: dumps, discharges and stockpiles

Current disposal

In temporary storage

Dounreay Prototype Fast Breeder Reactor and reprocessing plant
- Low-level solids
- Highly active reprocessed liquids
- Highly-active solids
- Intermediate solids
- Plutonium-contaminated wastes
- Low-activity gases and liquids

→ **Dounreay**
- Shallow dump holds about 20 000 m³
- Deep shaft held 20 000 curies of radioactivity when shut in 1976

→ **Tanks:** 800 m³ in 1975, c 2000 m³ in 2000 ❶
→ **Silos:** 250 m³ in 1975, c 2500 m³ in 2000 ❶
→ **Tanks:** none in 1975, 500 m³ in 2000 ❷
→ **Drums:** none in 1975; c 400 tonnes in 2000 ❷

Fuel manufacturing
Springfield fabrication plant
- Low-level gases and liquids
- Low-level solids

Capenhurst enrichment plant
- Some low-level liquids and gases

→ Stack disperses gases. Sea pipeline removes liquids
→ Stack disperses gases. Liquids to River Ribble
→ Clifton Marsh tip

Military installations
Reactors at Calder Hall and Chapelcross have similar wastes to Magnox commercial reactors (but the plutonium is used for bombs)
Chapelcross tritium plant.
- Low-level gases (mainly tritium) and liquids
- Solid wastes go to Sellafield

Submarine yards
- Fuel assemblies to Sellafield
- Solid waste
- Sludges from ion-exchange cleaning of liquids
- Low-level liquids, after cleaning
- Decommissioned submarines and (from Chatham) ion-exchange tanks

Aldermaston and Burghfield nuclear weapons plants
- Various solid and sludge wastes
- Low-level liquids and gases

→ Stack disperses gases. Liquids to River Mersey
→ Stack disperses gases. Liquids to Solway Firth
→ Buried in dockyards or military land
→ Dispersed through pipeline
→ Dispersed through stack and to River Thames

Sellafield reprocessing plant
The plant receives some 1600 tonnes of spent fuel from power stations in Britain and abroad for reprocessing each year
- Gases, mainly krypton
- Treated liquids
- Highly-active fission products from reprocessing
- Cladding cut from fuel assemblies
- Sludges and resins from treated effluents
- Plutonium-contaminated solids
- Miscellaneous intermediate solids
- Low-level rubbish, 15 000 m³ per year

→ Dispersed through stack
→ Pipeline to Irish Sea disposes of 1000 curies of alpha- and 100 000 curies of beta-radiation

→ **Tanks:** some 750 m³ containing 500 000 curies of alpha and 375 million curies of beta and gamma radiation in 1983, 2400 m³ containing 5 million curies of alpha and 2500 million curies of beta and gamma radiation in 2000 ❶
→ **Silos:** 6500 m³ in 1983, 10 000 m³ in 2000 ❷
→ 6000 m³ ❷
→ 460 tonnes in 1983; 10 000 m³ (including 1 tonne plutonium) in 2000 ❷
→ **Silos:** 5000 m³ ❷❸

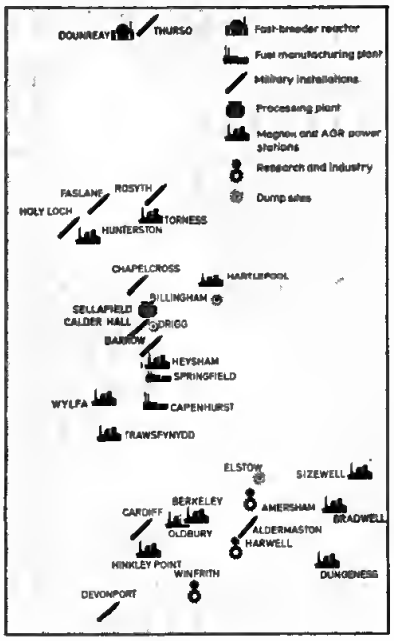
Magnox and AGR power stations
- Highly-active fuel assemblies go by rail to Sellafield
- Gases (mainly argon-41) and liquids
- Retained parts of fuel assemblies: 1000 m³ in a station's lifetime
- Core components: 450 m³ in a station's lifetime
- Sludges from effluent treatment: 200 m³ in a station's lifetime
- Low-level rubbish: 3750 m³ in a station's lifetime

→ **Drigg Dump**
- Some 500 000 m³ of low-level solids from Sellafield (also Springfield and commercial power stations) held in earth trenches

→ Stack-dispersed gases. Liquids to sea or Trawsfynydd Lake
→ 6000 m³ ❷
→ 2000 m³ ❷
→ 600 m³ ❷❸
→ 11 500 m³ ❸

Research and industry
Some 6000 premises, of all sizes, dispose of radioactive materials. Very low level wastes go to some 50 municipal tips. The rest joins the national disposal service run by NIREX from Harwell. Principal contributors are military wastes (from Aldermaston and elsewhere), the radioisotope factory run by Amersham International and laboratories run by the UKAEA at Harwell and Winfrith

→ Harwell waste has been dumped each summer into deep water in the Atlantic. Dumping of 3500 tonnes of waste stopped by trade union action in 1983. Few expect dumping to resume, given the international opposition
→ If the sea dumping stops then the waste will stay in store at Harwell ❷❸
→ Winfrith low-level liquid to sea



Proposed new disposal routes

❶ High-level waste: these wastes contain most of the radioactivity from the nuclear industry. It will eventually be buried deep underground. But ministers called off a drilling programme to find suitable sites two years ago. They now say the waste can stay in store for 50 years of more.

❷ Intermediate wastes with long-lived radioactivity: will be dumped in chambers in the abandoned anhydrite mine at Billingham, Cleveland, from the late 1990s, provided planning permission is given.

❸ Intermediate and low-level wastes with short-lived radioactivity: will be dumped in concrete-lined trenches in the Bedfordshire clays, provided planning permission is given.

◀ Soviet Union's Ural Mountains in the late 1950s. Western experts believe that massive radioactive pollution of lakes at the time was caused by a fission reaction of some kind taking place inside tanks holding large amounts of wastes from a weapons manufacturing plant.

In the late 1940s all manner of waste was dumped at sea by the US, during its Manhattan project of nuclear weapons development. Airmen reported flying planeloads for dumping into the Atlantic Ocean. One pilot claimed that the flight records were destroyed. Reports of the number of dump sites vary from 10 to 50. The official dumps, however, were in the Atlantic off Maryland and Delaware and off San Francisco in the Pacific. None of these was 4 km down—today's internationally accepted minimum depth for dumping. When the Environmental Protection Agency lowered submersibles at one dump it found that both plutonium and caesium had contaminated the sea bed. "Some of the containers . . . were seen to have many large white vasiform sponges attached, growing to a height of 1 metre," the agency reported. The sponges appeared to be a new, undescribed genus, and officials speculated that secretions from such sponges onto the drums caused the drums to burst open and release radiation.

UKAEA

In case of an accident, this is how a flask of waste would be rescued from coastal waters

All dumping of radioactive waste at sea is now banned in the US. But the US Navy recently floated the idea of dropping 100 redundant nuclear submarines onto the sea bed. They would join the pressure vessel from the reactor of a Seawolf submarine already dumped off Maryland. The Navy says that most of the radioactivity would be inside the corrosion-resistant parts of the submarines and so would be released into the sea only slowly.

In recent years the great majority of the radioactive waste dumped into the sea has been dumped by Britain. One irony is that attention has focused on the Atlantic dump (which appears to be safe), while, until Yorkshire Television went to town on the issue this week (see p 325), there has been little public concern about the pipeline, which extends just 3 km into the Irish Sea from the Sellafield reprocessing plant in Cumbria. Yet the discharge, into shallow water close to land and local fisheries, releases into the sea only fractionally less radioactivity than is released by the Atlantic dump.

So far there has been little concern over the gaseous emissions to the atmosphere from power station and reprocessing plant chimneys. But, according to the chairman of the UK Atomic Energy Authority, Sir John Hill, "when nuclear programmes expand worldwide, it will be desirable, or perhaps even necessary, to remove the krypton-85 and iodine-129". The krypton will be bottled until it decays. The iodine will be burnt inside a reactor.

The final, and most important, potential hazard from radioactive waste derives from the spent fuel from nuclear reactors. Wild notions of burying the fuel beneath the Antarctic ice or shooting it into space have been abandoned. And the idea of burying the waste on the ocean floor is meeting international opprobrium. Today most nations expect to dispose of their own wastes beneath their own territories. The spent fuel will either be buried intact or reprocessed and solidified in borosilicate glass, in a new process known as vitrification, to reduce the risk of leaching—but nobody can be certain how long it will be before radioactivity begins to leak.

The need for secure containment is strong. Some 95 per cent of the radioactivity produced in a working reactor finishes up in these wastes. So the waste must be buried deep underground —somewhere free of earthquakes (this could be a problem in Nevada and Japan, for example), away from minerals that might tempt a future generation of miners and in rocks that will not be invaded by groundwater, which could transport radioactivity to the surface. It must be protected for at least 10 000 years, says the US's Environmental Protection Agency. A panel convened by the National Academy of Sciences in the US said the rules should be even tougher—especially if unreprocessed spent fuel was buried, since it decays more slowly than reprocessing wastes.

The US is in the forefront of these developments. Thomas Pigford, a professor of nuclear engineering and the chairman of the US's Congressional panel on nuclear wastes, finds the challenge intriguing. He says: "Designing a system for such long-term isolation presents a fascinating challenge faced only a few times in the past, as when engineers of ancient Egypt designed the tombs of the pharaohs."

Earlier this year, the US government began work in New Mexico to develop a Waste Isolation Pilot Plant (WIPP). It will be a "demonstration site" for the "terminal isolation" of defence wastes. Quite separately, the US Secretary for Energy is about to announce a shortlist of three sites, one of which will be used to test the burial of wastes from commercial power stations. Both the civil and the military burial chambers will be some 600 metres down and reached by vertical mineshafts. Likely remote regions for the civil site include basalt rocks on the west coast, salt domes in the mid-west and volcanic material in Nevada where atomic weapons are tested. Under a strict timetable laid down in law, the first US permanent civil burial ground for civil waste will be in business on 1 January, 1988.

Many other nations are also starting to drill. Canada will open a fully fledged laboratory 240 m deep inside the Canadian Shield at Lac du Bonnet in Manitoba. The results of test-drilling in the Swiss Alps will be known next year and a site should be in business by 2020. India's nuclear engineers are busy digging 1500 m down in a mine at Kolar near Bangalore. Sweden intends to put its unreprocessed waste into thick copper canisters in an abandoned mine in central Sweden. But the country has decided, after a referendum in 1980, that it will build no more nuclear power stations, and its aim is to dispose safely of the waste from its existing stations. Sweden has one of the most advanced research projects for the burial of high-level wastes. The research is based at Stripa, a worked-out iron ore mine, and is investigating the geochemistry of groundwater at great depth, the migration of radioactivity through rock fractures and the behaviour of the backfill material, which many scientists regard as the weak link in any deep burial system.

Some of the results have been surprising. For example, it has been found that the salinity of the groundwater increases with depth, due to the leaching of very old salt water and mixing with fossil seawater. This could be important since salt water is extremely corrosive. The Swedes have found that the water flow within a rock fracture is "much more complicated" than generally assumed. But they have confirmed expected findings about the containment abilities of bentonite clay when used as a plug for the holes. The next stage of the project, in which Britain will be involved for the first time, will investigate the prospects for predicting fracture zones in hard rock deep underground and will look further at the migration of radioactivity and the plugging of shafts.

The nuclear industry is confident that the main technical problems for "terminal isolation" of these high-level wastes

Reprocessing: safe and sensible—or a proliferation timebomb

ONE CRUCIAL question for the world's nuclear industry in the next decade will be whether it is worth the trouble and cost of reprocessing spent reactor fuel before hurying it. The issue has as much to do with politics, economics and ethics as waste.

The first two nations in the West to develop a nuclear industry, Britain and the US, provide contrasting examples of how the spent fuel from civil power plants has been handled. In Britain spent fuel has always been taken to the Windscale nuclear complex (now renamed Sellafield) on the Cumbrian coast for reprocessing. British Magnox reactors, unlike other types of reactor, produce fuel that must be reprocessed. The fuel elements are chopped up and suhmerged in a tank of nitric acid. This dissolves the highly radioactive fission products (the "ash" of the reactor burn) along with the uranium and plutonium. The acid is then run through a further solvent, which separates the uranium and plutonium from the fission products.

This process is expensive, and at the end of it you are still left with a corrosive liquid that is highly radioactive and gives off heat. But there are compensations. The main one is a ready supply of uranium and plutonium. This can be fed back into conventional reactors, used to make bombs (this, of course, was why the process was developed) or kept in store for the new generation of fast-breeder reactors, which will feed off plutonium.

The British government has sold much of the plutonium from civil reactors to the US (for peaceful purposes only, it insists) but has retained a stockpile of plutonium at Windscale. This is kept separate from the military stockpile of plutonium derived from the Calder Hall and Chapelcross reactors, which is used for both British and American bombs.

In the US, fuel from military reactors is reprocessed to make bombs, but fuel from the civil power programme is not. Instead, for a mixture of political and commercial expediency and high principle, the fuel elements accumulate in giant pools at each power station.

Commercial expediency arises because the companies that run US power stations have chosen to postpone the day when they must find money to fund a final resting place for the waste produce. Political expediency arises because successive governments in the 1960s and early 1970s did not want to involve themselves in handling civil nuclear wastes. And high principle arises because the Carter administration decided that the risks of nuclear proliferation inherent in separating out the purified uranium and plutonium (a typical reactor produces 200-250 kilograms of plutonium each year) could not be justified.

(Others take an opposite view, however. Sir Walter Marshall, the chairman of Britain's Central Electricity Generating Board, argues that it is safer to concentrate spent fuel at "a small number of very large reprocessing plants". Otherwise "every reactor and every fuel storage facility would beome a 'plutonium mine,' becoming steadily more accessible with time, thus setting off a proliferation time-clock".)

Today, in the US, 12 000 tonnes of spent fuel is languishing in reactor pools. At 27 of the reactors, the pools will be full by 1990. Last June, the Department of Energy persuaded 46 owners of nuclear power stations to pay, between them, some $2 hillion as a down payment and further instalments of $400 million every year for the federal authorities to take away and dispose of their spent fuel.

The waste will eventually be taken to the planned "repository" for 70 000 tonnes of waste deep underground. But nobody is yet certain in what form that waste will be buried. Will it be the spent fuel as it leaves the power station, with its precious plutonium locked away for ever? Or will it be the reprocessed fission products, alone?

The economic case for reprocessing spent fuel is today weaker than for many years. A slump in reactor-building has caused a sharp drop in the price of uranium fuel. This both makes the reprocessed fuel less valuahle for recycling and makes the arrival of the fast-breeder reactor as a commercial proposition recede well into the next century. So, bomb-makers apart, who needs reprocessing?

Many countries are reassessing their requirements. The Soviet Union, which reprocesses both its own reactor fuels and those from Eastern Europe and Finland, is allowing a backlog to develop while its supplies of plutonium are plentiful. France and Britain lead the world in the commercial reprocessing of their own and other countries' spent fuel. But West Germany is still undecided about whether to continue to send spent fuel for reprocessing in France and Britain or whether to dispose of it directly into an underground dump, which is scheduled to open by 2000.

Even the British electricity industry may be getting cold feet. GEC, the giant of British nuclear engineering, is promoting the idea of "dry-storage" warehouses that can store spent fuel elements for many decades, keeping them cool with a complex air-conditioning system. GEC says the stores would be cheaper than conventional pools and less prone to leak. The warehouses could store the waste from power stations other than Magnoxes for 100 years or more—by which time the fuel would have cooled sufficiently to be buried directly. If, in future, uranium or plutonium increases in value, the fuel could still be removed from store and reprocessed. □

are solved. But some scientists argue that one of the leading types of rock proposed for "safe" disposal, salt beds, is a serious risk. Salt is excellent at dissipating the heat produced by the waste during the first few centuries of its confinement. And, when under intense pressure deep underground, salt has no cracks or fissures through which water might penetrate to the waste.

But there are disadvantages. Salt strata do contain pockets of brine, and if salty water should penetrate the burial chambers it will be extremely corrosive and will eat through most containers. Salt domes might be disturbed by people looking for oil or sulphur. And, of course, salt has always been sought out by man to sprinkle on his food. This has already led to trouble. The US's first attempt to construct a burial ground for high-level waste, at Lyons in Kansas, was abandoned in 1972, after seven years' work, because the salt dome turned out to be riddled with old mines.

The impact of an accident could be phenomenal. The Batelle Laboratories in the US wondered what might happen if miners 1000 years from now invaded a salt dome containing nuclear waste and inadvertently sucked up the waste along with salt during solution mining. The dissolved waste could, at the worst, be incorporated into salt used in food by 15 million people, say the Batelle scientists, and more than 200 000 people might eventually die from cancer.

Could this really happen? Pohl thinks so. "Based on historical longevity of past civilisations, and considering the great instability of present human institutions, I doubt that any specific event, in particular one that is as unglamorous as waste disposal, will be remembered for more than a hundred, or at best a few hundred, years. Thereafter we must suppose that our enterprising descendants would resume their drilling activities." According to Pohl, of the 150 salt domes in the US Gulf Coast region which would be at the right depth for waste disposal, almost two-thirds have been mined in the last 100 years. So "a human intrusion into the general area of a nuclear-waste depository within a few hundred years must be considered a near-certainty, if this depository is located in a geological medium containing salt or any resources that humans may want to use." He concludes that "salt formations must be judged unsuitable".

This is not a view accepted by most countries. In Britain, salt domes are still accepted as appropriate places for disposal. The abandoned exploratory drilling programme in Britain included the Cheshire salt field, which has been extensively mined for salt. The US is building its "test facility" in the salt beds of New Mexico. Denmark, the Netherlands and Spain have earmarked salt formations for disposal grounds. And West Germany, which has pioneered the use of salt, still intends to develop the salt dome at Gorleben in Lower Saxony by 2000. "Up to now," Bernd Reuse of the federal ministry of research and technology told a recent conference, "there have been no doubts about the suitability of the Gorleben salt dome." But in an industry where calculations have to be made about events taking place in thousands of years' time, "up to now" is a dangerous phrase. □

FORUM

Too serious for Professor Bailey

Ian Anderson reviews a strange outbreak of attitudes in California

A CONUNDRUM. What do the following items have in common:

* A robot-cum-coffee maker at the Lawrence Hall of Science at Berkeley
* The monthly magazine published by Friends of the Earth at its San Francisco headquarters, and
* The Department of Obstetrics and Gynecology at Stanford?

There are two answers.

Astute geographers will realise at once that all three organisations mentioned—Lawrence Hall of Science, Friends of the Earth, and Stanford University Medical Center—are located near one another in northern California.

But even astute geographers will not guess the second answer: allegations of sexism. Friends of the Earth and Stanford O&G are in hot water over the choice of words. The shape of the coffee maker has caused the fuss at Berkeley, but more of that later.

At Friends of the Earth, members have questioned the title of the monthly magazine ever since it was chosen 13 years ago. The title is *Not Man Apart*. Correspondents and mail deliverers frequently get the name wrong: over the years letters have arrived for *Not Man Alone*, *Not Man Apartments*, *No Manna Loan Company* and the like. But sexism, not mistaken identity, has been the chief complaint.

In recent weeks, the title has caused a less than friendly rift among the editorial staff that has spread to other office holders and now the magazine's subscribers worldwide are being asked their opinion.

Where did the title come from? The words were penned by Californian poet, Robinson Jeffers, in his work, *The Answer*. The poem includes the lines . . .

". . . the greatest beauty is organic wholeness,
the wholeness of life and things,
the divine beauty of the universe. Love that,
not man apart from that. . .

Battle lines were drawn on the editorial page of the October issue. FoE founder David Brower, magazine editor Tom Turner, and office holder Connie Parrish argued passionately for retention of the title; while four magazine staff members—Robert Schaeffer, Sandra Kaiser, Angela Gennino and John A. Knox—opted for change.

Brower *et al* say their opponents are too easily offended by words. They are taking the matter too far. "It is getting lost in Fiddles while Romes are burning . . . should sexist men retaliate by insisting that we call the journal *Father Earth News* in honour of the rarer sex that also inhabits the planet, or urge that we should give equal time to the Virgin Joseph?" The concept being conveyed is what's important.

Not Humanity Apart might cover the sexist objection (forgetting the "man" in "humanity"), they declare, but it would be bad poetry, and poets deserve respect, too. But Schaeffer and colleagues will have none of it. *Not Man Apart* does not pass muster on semantic or political grounds.

The phrase is ambiguous, they say, "containing as it does poetic licence and a negative way of expressing something positive. It is an obscure and arcane reference. Attempts to educate our membership about the meaning of the phrase in the context of the poem have not managed to popularise it." Instead, it is actually turning people away, people who might otherwise share FoE's work and goals. The umpires in this dispute will be the 14 member executive committee of FoE, which will decide whether or not to change the title after hearing from the membership.

At Stanford the judgment is already in. The chairman of the Department of Obstetrics and Gynecology, Dr W. LeRoy Heinrichs, was in error when he sent a memo to a resident doctor chastising her for having a baby. (Residents have completed medical school but train for up to five years to gain certification as a specialist.) The memo to Dr Zena Levine, now five months pregnant, said in part:

"The attitude of most of us on the faculty has been that planning a pregnancy during a training period as intense and demanding as that of a three year ob/gyn programme is presumptuous and a disservice to oneself and certainly to one's professional colleagues.

"Pregnancy can also ultimately affect patients who must bear the frustrations of your colleagues who must work with you or those who remain in your absence. Some faculty express the modern view that responsible career women do not risk incurring the age-old criticism of women as unreliable professional colleagues and some advise me, for that reason, to appoint no more women as residents in this program."

Heinrichs made matters worse by suggesting to Levine that she delay a planned vacation in October and use the time "prudently in relation to your pregnancy". What is more, he sent copies of the memo to others in the department.

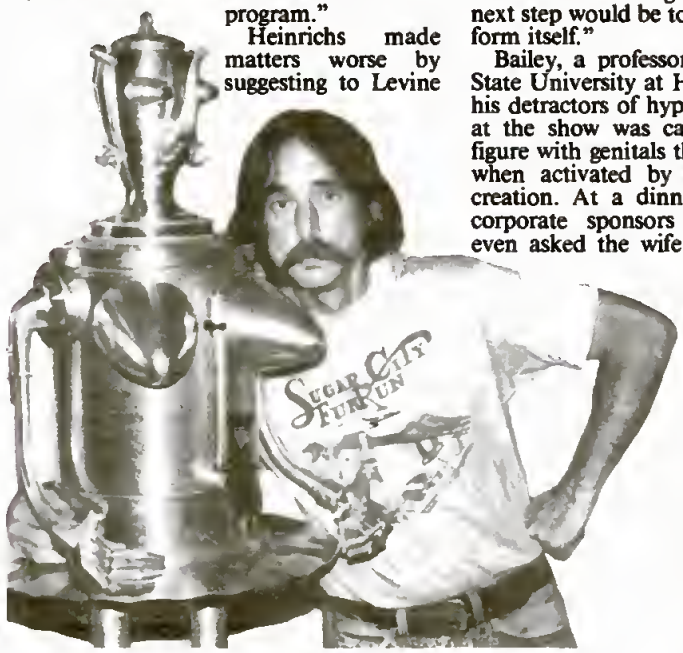
The reaction was strong and immediate. the memo was "highly inappropriate, offensive, insensitive, and most importantly, unusable", said the dean of the Medical Center Dominick Purpura, who equated the document with Atilla the Hun. He later apologised for his historical metaphor, but the objection still stood. Heinrichs has apologised to Levine and the other female residents and disavowed the earlier remarks in a second memo. Now a grievance committee has been set up to deal with the issues raised.

Over at Berkeley, artist Clayton Bailey sees a parallel with Brower's position at FoE. The feminist movement at Berkeley has gone too far, says Bailey, whose busty female robot was removed from an exhibition at the Lawrence Hall of Science after employees and members of the public presented a petition to the hall's deputy director. Bailey is incensed. He calls the action "censorship" and next to "book burning". (The robot has been exhibited in six other museums and galleries and never raised an eyebrow.)

The Fuss is over *Sweetheart*, a five foot robot made up of recycled metallic objects. *Sweetheart* is a functional coffee maker with baseball bat legs, a coffee pot head, a coffee urn torso, vacuum cleaner parts for hands and arms, and two desk lamp shades for the most controversial bits—the breasts. "It's the world's most beautiful lady robot," Bailey told me last week,. "It's in the tradition of classical female beauty which has been depicted in art for centuries. To ban this is like banning Venus de Milo. The next step would be to condemn the female form itself."

Bailey, a professor of art at California State University at Hayward, also accuses his detractors of hypocrisy. Another work at the show was called *On/Off*, a male figure with genitals that buzz and light up when activated by a person inside the creation. At a dinner party for wealthy corporate sponsors *On/Off's* occupants even asked the wife of the state's superintendent of public instruction to run away with him. But, says Bailey, nobody ever objected to *On/Off's* display of sexual prowess or suggestive banter.

"It seems that when a male is depicted it's fun, but these days when a female is depicted it's serious." □



Ron James

Sweetheart, *Clayton Bailey's coffee urn*

Going for gold

Tam Dalyell explores some Inca heritage during a visit to Peru

EVER SINCE my childhood, when the late Professor Gordon Childe, the Australian-born archaeologist, used to come to our house, I have been fascinated by the early art of metallurgy. Thus, during a four-day visit to Peru to see President Belaude Terry about his country's peace plan for the Falklands, I indulged myself on two free afternoons by looking at Pre-Columbian metallurgy at the Museum of Gold in Lima. Here is a hoard of treasure dating from the 1000 years before the Europeans stormed the Inca Empire in 1532.

The South American Indians gained practically all their gold from river beds ("lavaderos"), where they washed the gravels for precious metals, but some of it they won from gold-bearing sands. Only occasionally did they find any surface veins. The Incas melted their gold in baked clay-and-lime pots. At least one person was in charge of producing a "blast" for these early crucibles. He had to blow through long tubes over the flames.

The Incas found that it was best to prepare an alloy rather than a pure precious metal. Sometimes they wanted their metal to be hard, othertimes they wished to increase its apparent volume. But on some occasions they used an alloying principle just to achieve a lower melting-point. My Peruvian hosts explained to me that the Indians often had problems with melting the gold and they were hard pressed to achieve sufficiently high temperatures in their primitive furnaces. However, by the year AD 100, the Chimu tribesmen had discovered that the addition of small quantities of another metal reduced the melting point of the gold.

The Museum of Gold contains many elegantly worked objects fashioned by early goldsmiths, sometimes with more than one alloy. Analysis of the components used has

thrown light on the process and methods that the Incas adopted in manufacturing both the main body of their artefacts and in covering them with gold or silver. They started with ingots and fashioned them into sheets of 1 to 4 mm thick by hammering, laminating and reheating. Such processes caused the alloys to harden, and often to become somewhat fragile. But hammering and heating caused any copper present in the alloy to rise to the surface, where it became oxidised to give a dark film. This the goldsmiths etched away with acid. For acid and corrosive effects, the Pre-Columbians used a paste that they made by mixing soil with a high concentration of potassium nitrate, alum, common salt and water. The Great Inca and his mates may not have discovered the wheel, but they turned out to be no mean practical chemists!

The working processes gave the objects a bright and smooth appearance due to the consolidation of gold or silver particles on the surface. However, because of the thinness of the gold and silver layers, corrosion has created serious preservation problems for museum curators.

The goldsmiths tinted their gold in different shades by carefully controlling the purity and proportion of the secondary metal added to form the alloy. Their reddish gold contains a certain amount of copper and this imparts a warm hue; their white and yellowish golds are alloys with silver. Other effects that I noted were the result of the various components of the alloy having oxidised during burial—especially from interaction with gaseous emanations when the object was associated with a mummified body.

I was amazed that despite the dedication and time-consuming workmanship lavished on objects made with gold and silver, many goldsmiths covered their products with red paint (cinnabar—the ore of mercury), green and blue paint (copper sulphide) and yellow paint (ammonia). Many of the artefacts were covered with feathers, some with leather and others with textiles. Sometimes the objects are so smothered that it is difficult to appreciate they are made of gold or silver. But clearly a mystical value was attributed to many

Computer takeover, but what?

John Bell's anger is fired by some software waffle

IF, MAY the gods forbid, you find this stuff pretty boring to read, you should try writing it. Better still, you should try reading some of the stuff that people expect us to read before we write for you. Take a recent press release, for example.

The headline read: "Britain's top executives expect computers to lose jobs." Of course, "lose" should have read "destroy" but the error inevitably stirred the imagination. Could Herbert Arkwright (Prop.) really peer over his gold rimmed half-frames at the computer print out, gently pale about the jowls, and bellow down the intercom: "Mainframe, You're fired"?

This particular announcement, from a maker of business systems, concerned a survey of senior managements' attitudes to computers in the office. As the firm builds such instruments, not too many eyes will widen at the discovery that most managers would indeed like a personal computer. Of course they would, computers are good for the image.

Surveys disturb me. It's not that I cannot believe exactly 41.5 per cent of the population is ever for or against anything, the language of surveys confuses. This particular firm's investigation of 200 "top executives" (whatever they are) led to the announcement: "A surprising 79 per cent of directors and senior management from Britain's leading companies think it is a good idea that they should use computer keyboards . . . " What is so surprising? The size of the sample, or was everyone told that "surprising top executives only need apply"? And what should they use the keyboards for? Typing? Or do they just want keyboards and no computers?

The claims continue: ". . . but 57 per cent cannot envisage themselves working from home." May one retort "piffle"? Who ever heard of a "top executive" without a briefcase of papers for scanning in the back of the company Roller, or beside the pool?

Apparently, this dissention about homework will "possibly cause problems for some of our top companies". (A "top company" is one found in the *Times Top 1000*, by the way.) What can all this mean? Unionisation of the boardrooms of the land with messages of solidarity from brothers and sisters on the shop floor?

No. It seems that office space costs so much that "top companies" want their "top executives" to work at home because it saves on the rent and rates. Herbert Arkwright (Prop.) would love that: make 'em pay to work for you.

Just over 40 per cent of the sample had seen jobs destroyed by office automation; 45 per cent expected to see more jobs go the same way. The survey also reveals: "In general, it is felt that lower-level, less-skilled jobs would be the ones to go. In plain English, that means "top executives" are not so stupid as to replace themselves with a computer, and that automation cuts your payroll. Was a survey necessary to find such wisdom?

The best bits of this seven-page press release are the advantages and disadvantages of office automation listed by the nation's "top executives". Among the good points—after efficiency, speed, accuracy and so on—come "information—achieves the impossible" and "novelty". Perhaps there are video games for word processors now. The bad points—following "machines take over and rule" and the need for education—included "produces too much information", "requires discipline" and "too much manual effort required". Our "top executives" will obviously need "top secretaries" to do their typing for them.

Now there's a topping idea for a survey: What do "top executives" need their "top secretaries" for? Would the Brighton Chamber of Commerce like to commission it? Office automation may never be the same again. □

FORUM

objects and they became loyal companions, during life and death, to the ancient Peruvians. Despite the concealment of the glittering surfaces, the objects fulfilled magical and religious functions.

One question of technique especially intrigues me. A few cultures used the wax-casting method, but much work was done by beating the metal until a sheet or plate was obtained, whether using alloys or the 24 carat goldwork. To avoid leaving traces of hammer and/or anvil, the Incas buffered their beating hy interposing tough weaves between the metal sheets. The sheets, thus obtained were worked hy repoussé, trimming, polishing, hurnishing, plaiting, drawing, etc. These skills were mastered with a range of stone and metal instruments. The Indians practised various techniques with their more complex pieces. The most outstanding among them were crimping, stapling, riveting and especially soldering.

There remains, however, one central question which to my mind has never been convincingly answered. Why did a society that had achieved this level of technology fall prey so easily to Francisco Pizarro, his handful of conquistadors and a couple of score of nag-like horses? □

Viking descendants land on the Falklands

Sara Webb on new uses for rare breeds

THE LATEST INVASION of the Falkland Islands was no cause for consternation in Downing Street. But then, most of the beasts that stepped ashore at Port Howard on 22 October were of the four-legged and cloven-hoofed variety.

The 224 domestic animals sent from Britain hy the Falklands Appeal to replace livestock killed in last year's fighting include Saddleback pigs, Jacoh sheep, Exmoor ponies plus a herd of Shetland cattle. The five cows in calf, and a bull, are a gift from the Rare Breeds Survival Trust—at first sight a surprising gesture considering the breed's rarity in its native land.

The Shetlands are descendants of cattle reared by the Vikings. As employment in the islands has shifted from crofting to meet the demands of an expanding oil industry so the number of cattle has dwindled. In 1980 when the future of the breed looked precarious, the Rare Breeds Survival Trust bought up all the remaining animals and moved them to farms where they would be bred pure. In addition, the trust secured a grant worth £19 000 from the Shetland Island Council to encourage farmers to hreed pure cattle. For each pure-bred calf, the farmer receives £100 plus £200 a year towards maintaining a pure-hred hull.

However, with only 121 adult cows and a small number of hloodlines left, why send six Shetlands halfway around the globe? Perhaps the trust is performing its annual stock clearance, palming off an archaic and out-dated hreed on a group of islanders whose cries of protest will not be heard?

Not so. The unique characteristics of the breed are of genuine interest to the Falkland islanders. Shetland cattle are hardy animals, capahle of thriving on poor grazing. Moreover, they are a dual-purpose hreed—while the cows produce adequate milk yields, the hulls can be fattened for beef without the need for concentrates or cattle cubes. In this respect, they differ from many commercial hreeds which are selected either for milk yield or meat quality and which therefore require good pasture or supplies of cattle cubes.

The herd's destination is the 200 000 acre estate at Port Howard, West Falkland, owned by James Lovegrove Waldron Ltd. Afflicted hy poor grassland and peat bogs, with constant high winds and driving rain, the area bears a marked semblance to the Shetland Islands. Furthermore, although oats are grown, they do not ripen at this latitude. Instead, they are cut green and used to supplement the sometimes scanty hay harvest. The cost of importing cattle food is prohibitively high due to broken trading links with South America, so the Shetland's hardiness makes it the ohvious choice, both ecologically and economically.

Although the Shetland herd will be hred pure in the Falklands, one of the projects planned is to cross them with the Ayrshire cows already on the estate. This, it is hoped, might increase the beef potential of male calves thereby cutting the cost of feeding more than 8000 islanders and military personnel. Ideally, the animals should have come from widely different bloodlines, hut uncertainty over the date of departure posed problems and the five pregnant cows available at the time came from quite closely related hloodlines. Even so, they are accompanied hy an unrelated hull and their calves were sired hy hulls from different hloodlines; in future, sperm from rare bloodlines may be sent from Britain for artificial insemination.

If the installation of Shetland cattle on the Falklands proves successful (and there is no reason why it should not because they are well adapted to a similar climate and terrain) the trust will deserve a pat on the back for taking an interest in the breed long before its potential could be gauged. By donating the Shetland herd, the trust hopes to draw attention to the plight of rare breeds in general and to the need to preserve a range of unique genetic characteristics from meat quality to mothering ahility for use in future farming programmes. Soay sheep, for example, are known to produce very lean meat which could be of value to people with heart problems, while the Hehridean sheep from St Kilda are of interest because they eke out an existence on poor pastures where commercial sheep cannot survive, let alone grow fat.

Beef production has been influenced by the use of rare hreeds already. The tendency to use hig continental hulls on heffers can result in calving difficulties because the heffers throw large calves. Often, both heffer and calf are lost, which is very expensive for the farmer. Consequently, there has been a move towards using the rare British Whites and Longhorns, both of which are known to calve easily, as sires on heffers.

In many instances, the problem arises of actually pinpointing what "useful characteristics" are worth preserving. People are less likely to want to save a rare breed of cattle that has no foreseeable use, and most farmers prefer to stick to the popular commercial hreeds rather than dabble with rare livestock. As one cynical farmer put it, "Rare breeds are something of a rich man's hobhy—they've become fashionahle over the past few years because people are more concerned about conservation. Besides, a herd of rare cattle looks very decorative on the manor's front lawn." However, for many breeds, the concern for conservation came too late. Since the turn of this century, 30 British domestic breeds have died out—whether any more will follow suit depends largely on the open-mindedness of the farming community. □

Sara Webb recently graduated in zoology at the University of Oxford.

Alec Paris Publicity

Soay sheep, the new outer garrison for the Falklands

Not all red herrings are ghoti

Roy Herbert makes a plea for consistent spellings

THERE IS a new word being bandied about, though not by me, a confirmed non-bandier. It is being thrown headlong into the language by advertising agents, and I discover that my mother suffered from what it describes. One of James Thurber's eccentric relatives was unshakahly of the opinion that if you took a lamp out of a fitting, the electricity would leak away. My mother had an uneasy feeling that she was right. It simply reinforced her view that the world was being made more dangerous every day by technological development. She would never make a telephone call, for example, because she knew that one day the thing would explode. All calls were made by my father and my mother went round the corner from the box, just in case.

She was, I learn, ahead of her time. She was an early victim of "techno-fear". I know all this because the owners of a chain of electrical shops commissioned an advertising agency to make a survey and the agency invented the word as a convenient way of describing what they were on about at a press conference to lay out the results. The definition of the word is "difficulties in accepting and using high technology products in the home", which only goes to show what a severe case my mother was. High technology was bad enough on the street in a red box. She would have defended her home against it ever coming in, probably with a hroom, a product of low technology and about as technological an article as she ever wanted to own.

My interest in the suhject does not centre on the products. I do not suffer from techno-fear. Why, I have a pocket calculator and have had it for several weeks. I keep taking it out and looking at it fearlessly, resisting a self-congratulatory glow at being one of the avant-garde. It is the word itself that I have had in mind ever since I read it.

It is a bastard production, a mixture of Greek and Saxon, or at any rate old English, as far as I know. It should, I reckon, have been polished up a bit before being hurled into circulation and come out as technophohia. Immediately, then, you have more words at your disposal—technophobe, technophilia and technophile. And, because these words are made up from familiar roots, you can wrest the meaning from them without having seen them before. (The other way is hopeless at this extension. Techno-lover? Technohater? Before you know where you are you are into Red Indian, as in Man-afraid-of-technology.)

But the important point is that you have to see the words to extract the meaning and here comes the bane of some educationalists and many would-be reformers of the language, who range from those who do not think spelling matters to those who want to change the way words are spelt hy what they claim is a simpler and more logical system.

Every time this suhject comes up somebody will mention Shakespeare and the way he apparently either could not spell his

name or fancied other ways of doing it, including W. Shagsper. This is a sidetrack, a red herring. It implies that what was good enough for Shakespeare is good enough for us. The world has changed since then. Even so, Shakespeare was trying to find a spelling he could stick to. I imagine that those of the groundlings who could read took their seats muttering, "Who's this Shagsper, then? Somebody else cashing in on the Globe, eh? What's he wrote, Mack?" or the Shagsperian equivalent, not recognising the name.

One of the reasons for us all to spell words in the same way is identical to that for standardising the pitch and size of screw threads, or, for that matter, the pitch and length of musical notes. It makes international effort and communication easier. We can write letters to each other and we know what we are talking about. Using the sound of words alone is not enough for this.

Take one of the words concerning attitudes to technology, technophile. The reformers have a number of ways of spelling it, from what I have seen. One might be teknofile. It sounds the same, and both could be the words of a Birmingham librarian prohibiting someone from removing a folder from his archives. When the words are written down, the reformed spelling looks as if it might, indeed, have something to do with filing. But once you know that words with "phile" in them are probahly formed from the Greek philos, a friend or lover of, you are a long way towards understanding. You are likely to get some idea of the meaning of, for instance, philanthropy. Spelt as filanthropy, the word has no particular connection with teknofile.

I do not want to labour the point, but it seems to me that all the ranters about the difficulty of spelling are up against it. They may remove some problems, but they introduce as many as they solve. An excellent instance of the difficulties of forcing spelling to fit the sound is a derogatory term used in some circles at the moment. Someone to be despised is described in print as a "toe-rag". It is meaningless. There is no such thing as a toe-rag. But there is a tow-rag, a rag made of tow, for wiping oil off machinery. It is waste, in other words, and makes some sort of sense as a sneer. We all know that a foreskin is different from a foursome, but there is apt to be confusion, if not worse, if they are spelt, as they might be, as fawskin and fawsome or forskin and forsome. It would not make for an easy reed, as a clarinet player might be reported as remarking.

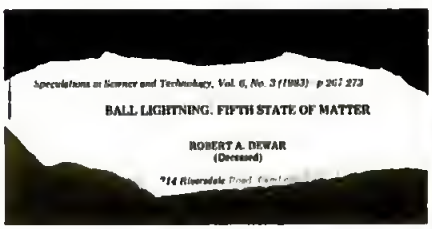
The objection to, as a microhiologist friend of mine was wont to opine (and try that in any nu sistem), "huggering about" with spelling is a practical one. For a start we should all have to learn to spell all over again. What would we do for dictionaries? They would all have to be handed in and we should all have to be given, or more likely we should all have to buy, new ones. Compilers would go tearing through the streets, insane. Compositors would demand pay that would bankrupt any printing firm. Proof readers would all leave for Australia. Industry and commerce would grind to a stop as all the words we are familiar with had to be looked up. All the computers would have smoke coming out of their memories.

The new dictionaries, incidentally, in order to make some sort of sense in defining words, would have to quote their roots just as they do now, so chaos or kayos ("punches rendering opponents unconscious") would rain. I cannot believe that anyone would want, at a stroke, to cut us off from the fascinating history and development of language, apart from most of literature, including Shagsper, so the whole operation would be nugatory.

Worst of all, there would be the utter ruin of one of the best developments in the long travail of humanity since the Tower of Babel—and that is the rosy probability that everyone in the world will eventually speak English, if not as a first languagc, then as the international one. Much as this irritates the French, there is not much chance of any other language taking over this potential role.

I am not one who takes the view that a common language is necessarily a uniter of different peoples or nations, but it is a step in the right direction. If your German correspondent is to be faced with writing "I am ouell, how are u?" instead of the polite inquiry he now knows by heart, there is every chance of relations becoming thorny. The French, of course, are already a bit *fromagé* at having to include English words in their own language. If they are suddenly thrown by having to spell "le football", "le goal" or "le five o'clock" as "le futbawl", "le gole" and "le five o'klok", to be *comme il faut*, as we say over here, then there will be big trouhle in the EEC, at the very least.

Not that the reformers agree on future spelling. They do not and have not since Bernard Shaw tried it and before that for all I know. Long may dissension, disenshun and dissenshn flourish. Divide and conker is a good rool though a bit of a chestnut (Applaws). □



FORUM

Hi-fi and the Second World War

Arthur Haddy recently talked to Barry Fox about his experiences of, and contributions to, recording sound at high quality

ANYONE will tell you how micro-electronics made the Moon shots possible and how spin-off from the space race gave us calculators, digital watches and home computers. But it is less well known that high-quality sound reproduction helped win the Second World War and research spin-off from the war effort gave us hi-fi in the home. One man who remembers it well is Arthur Haddy, technical director of the Decca Record Company until it was broken up and bought by Polygram and Racal.

Haddy spent over 50 years at the Decca studios in West Hampstead. He was behind the company's world famous catalogue of classical recordings, including the complete Wagner Ring Cycle. During the war, Haddy was paid by Decca but was on call to the RAF. One job was to help it decode German night fighter transmissions.

"We used to go down to West Kingsdown in Kent. There were around 300 WAAFS, all Czechs and Germans, listening on receivers tuned to the German night fighter frequency. Not even a tractor was allowed in the fields within three miles. You couldn't take a motor car anywhere near the place. We had to walk the last few miles. Interference was the problem, because they didn't have suppressors then. The RAF laid on raids specially to get the Germans talking about what was happening and when. That gave the code breakers their clues. "All the fighter radios were voice operated, they only transmitted when the pilot spoke. So we had to record everything on disc. We had two complete sets of equipment so recording never stopped. We would cut around 100 wax discs during a raid. They all had to be processed back at the studios, with filters to remove the whistles. Then it all went back to the RAF for decoding.

Hi-fi society, Bing Crosby made his last recording with Arthur Haddy

"We did another recording job. All British fighter planes had a device called IFF (Identification Friend or Foe). It was a little black box that exploded when it was opened, in case the aeroplane was brought down in Germany. The pilots used to switch these things on when they came back across the coast so that our anti-aircraft guns could identify them. They transmitted a sound rather like the noise you get from a modern computer program or tape. The idea was that it could not be copied. But we had to teach all the anti-aircraft gun operators to recognise the noise. There wasn't enough IFF equipment to do it live. So what we did was make high-quality disc recordings, and send them out to all the anti-aircraft gun stations. We made the recordings in the Decca West Hampstead studio. They had an armed guard on the place. One engineer was nearly shot when he went to the pub for lunch and came in through the studio back door.

"Obviously the recordings had to be of high quality, but our real problem was on Sonar Radio Buoys. Coastal Command flew out over the Atlantic and when it thought it had located a submarine it would drop three of these buoys in the shape of a triangle. Each buoy had a very sensitive underwater microphone and a short wave radio that transmitted the sound up to the aircraft. So the crew could listen on headphones to the sound under water. When they heard a submarine getting louder in one buoy microphone, they'd drop another three buoys over it in a smaller triangle, and go on doing that until it was tied down to a couple of hundred yards. Then they would pattern bomb that small area.

"Shipping losses were very bad so Churchill gave orders that if an aeroplane located a submarine in the Atlantic and Coastal Command couldn't be sure whose it was, it had to bomb it anyway. We lost some of our own submarines that way. The only give-away was the noise of the water leaving the propellor. A German submarine sounded quite different from an English submarine. There was no mistaking it once you knew what to listen for. But the telltale difference was a very high-frequency sound.

"There were hundreds of pilots in Coastal Command and there weren't enough radio buoys to go round, for training. They were big things, around 8 ft [2·6 metres] high, very heavy and all valves of course. So the RAF hit on the idea of recording the sound for training. 'Can you record the high frequencies?' they asked me and like a fool I said yes.

"We had to build a disc cutter that would handle the full range of human hearing. We built one that would go up to around 16 kHz. Then we recorded the propellor noise from a captured German sub. Also the noise of a British sub. On headphones you could clearly hear the difference."

After the war Decca used the same cutter head to produce a catalogue of high-quality music recordings that were sold under the trade name FFRR (Full Frequency Range Recording). It became the company's trademark and, for the first time ever, made the general public aware of hi-fi. Because of the wide range of frequencies available, Decca engineers were able to record stereo using a multiplex technique. One channel was recorded at high frequency and the other at low frequency. They made a test recording of Vera Lynn in one channel and a military band in the other. But the technique was abandoned in favour of stereo as we now know it, with each channel recorded on a separate wall of the groove. One of Haddy's original FFRR cutter heads is now with the Science Museum in London.

Hitler also inadvertently helped hi-fi. Arthur Haddy recalls how:

"Our navy was baffled because German ships were able to communicate with some curious kind of message that our people couldn't decode. It turned out that the Germans were using a tape recorder, built by Telefunken. It used paper tape and went up to only 4 kHz, but they could record a coded message at ordinary speed, transmit it at 10 times normal speed off tape, record it at the other end and play it back at one tenth the speed. It's the way that music and computer tapes are duplicated at high speed now.

"At the end of the war, one of our Decca engineers, who was with a radar group, saw a Telefunken recorder on a German battleship and nicked it. We had it in the studio for a while and it was quite good. But of course you couldn't get spares for it." □

ENIGMA

No 236

Men on a bummel

by Martin Hollis

ON THE LAST NIGHT of their German holiday, Amble, Bumble, Crumble and Dimwit ate at *Das Goldene Rätsel*, famous for its Anglo-German cuisine. Each had one dish from each course. Here is the menu.

Lumpensuppe	DM 2
Uferschnecken	DM 4
Aalspastete	DM 5
.....	
Blase und Gequiek	DM 4
Kröte im Loch	DM 8
Badeburschen	DM 10
.....	
Mausefallekäse	DM 3
Walise Seltenstück	DM 5
Geflechte Polizistenpudding	DM 7

Dimwit is, alas, now recovering from food-poisoning and too ill to recall what he ate or spent. Nor can the others recall, but the three spent the same amount each and know what each of the three ate. Making the reasonable assumption that Dimwit was done for by something which he alone chose, they have deduced what the offending dish must have been.

Can you do the same?

A £5 book token will be awarded to the sender of the first correct solution opened on Thursday, 17 November. Please send entries to Enigma No 236, New Scientist, Commonwealth House, 1-19 New Oxford Street, London WC1A 1NG. The Editor's decision is final. The winner of Enigma No 233, Imagine an Enigma, was Oliver Dixon of Camberley, Surrey.

Answer to Enigma 233

Imagine an Enigma

64691

Get this into your heads

Your cassette recorder is only as good as the audio tape you put into it. So why not use the best? And now that JVC have launched their Dynarec series, you won't find better tapes.

JVC is the company that sets the standards to follow in all areas of audio and video equipment.

To give you recording quality you've never heard before, JVC have developed a special binding process on the surface of their tapes. This makes for smooth responsive recording whatever your requirements. And all JVC tapes have a head-cleaning leader to ensure clear, noise-free recording time after time. Everything has been done to enhance performance right down to the precision moulded cassette shell.

The Dynarec series is a range of tapes created for today's exciting audio world, the world of PCM digital recording and Compact Disc Digital Audio.

Whether you're into the sophistication of metal tape recording or just want perfect day-to-day sound, JVC has the right tape for you.

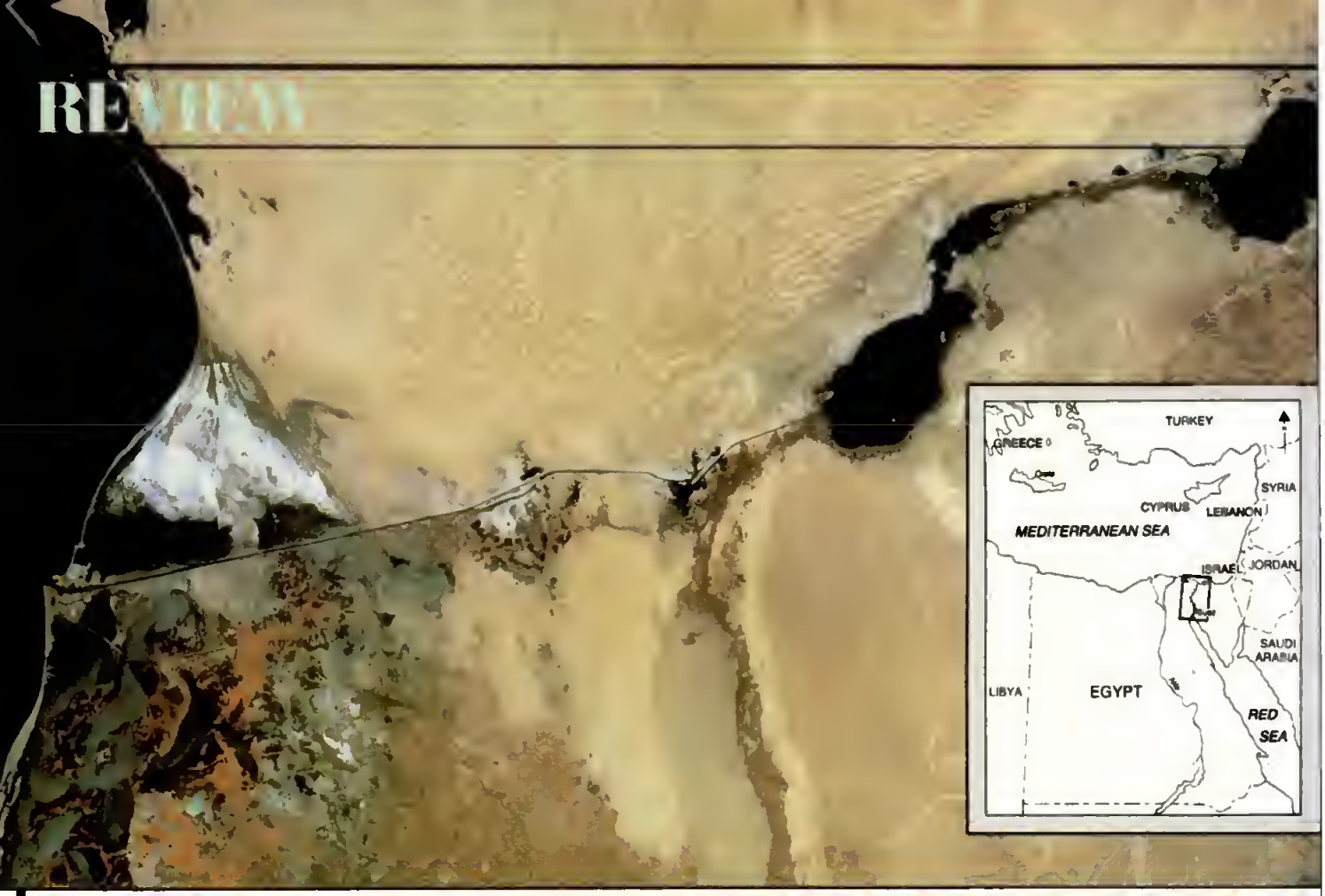
JVC

You've either got it, or you haven't.

Johnnie Walker
BLACK LABEL

Other pleasures pale beside it.

NOTHING ELSE MEASURES UP TO JOHNNIE WALKER BLACK LABEL



Satellites view the mark of man

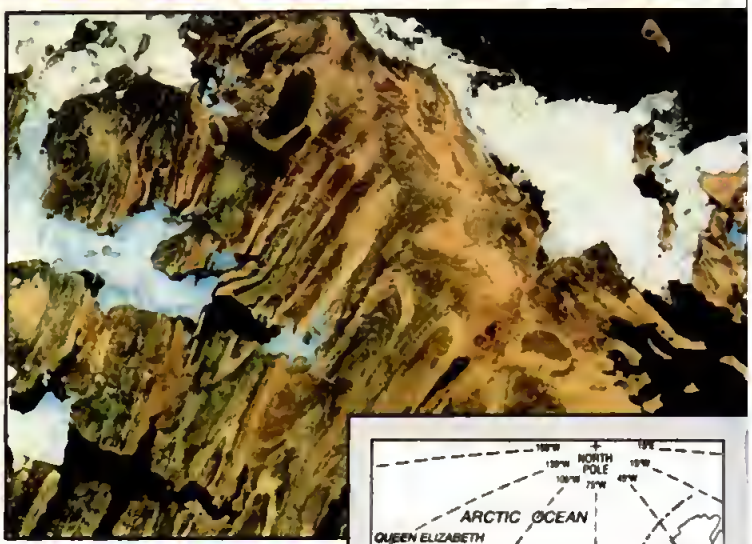
Man on Earth
by Charles Sheffield, *Sidgwick & Jackson, pp 160, £12·95*

John Gribbin

I FIRST became aware of Charles Sheffield through his science fiction. His books are some of the best modern examples of the sub-genre known as "hard" SF, in which the science is, as far as possible, not only genuine but up to date. Anyone who can write entertaining stories accurately based on the general relativistic description of a rotating black hole, and make punning use of the expression "killing vector", has a talent to be reckoned with. I mean it as the highest praise when I say that in *Earthwatch*, and now *Man on Earth*, Sheffield has applied the same meticulous skills.

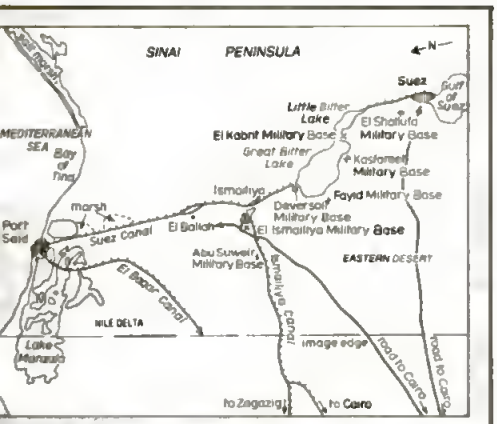
The satellite images of Earth in these books are taken from the Landsat series of spacecraft, and although *Man on Earth* follows the format of its successful predecessor, it concentrates on showing how humans have changed the surface of the Earth. The essential point to remember when looking at these computer-enhanced images is that they are "false-colour" pictures. The long infrared wavelengths appear as red, true red is shown as yellow, and true yellow appears blue. Typically, crops and other vegetation show up as shades of red, urban areas grey or grey-blue, clear deep water is black, and muddy or shallow water appears as various shades of blue. Of course, expert interpretation of the images is needed for most commercial use, but just thumbing through the pages of the two books with these simple rules in mind provides a mind-blowing wealth of information for the general reader.

Sheffield's team has meticulously prepared the presentation of each image alongside maps showing its place in the world and a text of a couple of hundred words explaining the significance of the details in the picture. It is fascinating to see a political boundary standing out sharply in an image, taken from an altitude of 917 km, of the Negev desert; the cultivated land on the Israeli side of the border is darker grey than the unproductive region on the Egyptian side. The border runs like a ruled line across the region. With the recent fuss about spy planes and the like, the Landsat picture of Moscow makes even the casual reader pause to contemplate just how good the unpublished images from military satellites must be.



But pictures like this have a direct practical benefit to mankind, as well as providing opportunities for political voyeurism. The picture above shows most of Bathurst Island, in the bleak Canadian north. The North Magnetic Pole lies in this region at 76° N, familiar, perhaps, to airline passengers

who have taken the polar route to San Francisco. The folded geological belts so clearly visible are typical of the formations which, deep below the surface, are often associated with concentrations of oil and gas, and Bathurst Island sits near the centre of a huge sedimentary rock basin covering 1 720 000 square kilometres. Bleak and inhospitable though this region is, half way from the Arctic Circle to the North Pole, the attention of the oil explorers must inevitably turn there as other reserves decline.



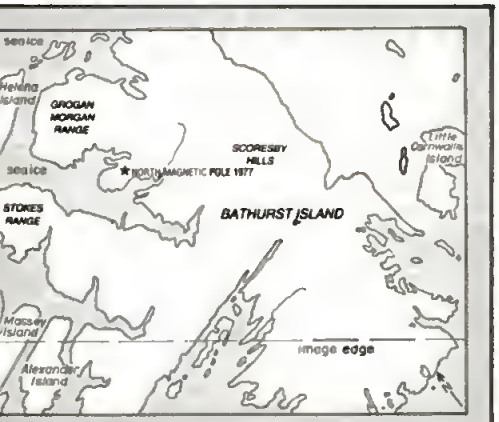
The Suez Canal
In the 1860s, man altered the face of the Earth to create his own route to India and China

Man has already made his mark, of course, on regions comparably bleak and inhospitable. The top picture on the facing page shows the Suez Canal in its entirety, from the head of the Gulf of Suez, on the right, to Port Said on the left. The light tan sand dunes of the Sinai Peninsula, in the top half of the picture, are up to 90 metres high; the bright "rivers" on the other side of the canal are the dry wadis of the Egyptian Eastern Desert. Below Port Said we see Lake Manzala, and above the black patch of another lake. The dark brown patches farther to the right are marshland, and the distinctive bright, white areas are flat sand and salt. Seven military bases and airstrips are visible in the picture – back to politics again – as well as the long, slightly curving lines of major roads and canals.

There is enough information provided in *Man on Earth* but not so much that the reader is overloaded or that the words take away space that could be better used for pictures. The maps precisely complement the photographic images and answer the questions that come to mind from a quick look at the images. It is true that Sheffield includes only a brief explanation of the satellites and imaging process by which the pictures are obtained, but the complete background is available in *Earthwatch*.

Bearing in mind that one such "photograph" purchased for commercial use from Earth Satellite Corporation, the company of which Sheffield is vice-president, can set you back a three-figure sum, the scores of images in this book represent amazing value as art, entertainment, or providers of scientific information. If this is typical of what the corporation can put together, then it must have a lot of very satisified customers who make professional use of its expertise.

Where do we go from here? With four Landsat craft each returning data covering more than 10 000 km^2 in the time it takes you to read this sentence, there is clearly scope for a few more books in the series. But these satellites are already old hat. The French plan to launch SPOT next year, providing images of details down to 10 metres across and permitting accurate identification and mapping of all major streets, parks, large buildings and bridges of a city. It could put a whole new meaning behind those "you are here" messages on maps. □



Bathurst Island
An area still not fully explored, but Landsat images suggest oil and gas are there

Earthwatch is also available from Sidgwick & Jackson, price £10.

REVIEW

Biography of the bomb

Project Y: the Los Alamos story
Part 1: Toward Trinity by David Hawkins
Part 2: Beyond Trinity by Edith Truslow and Ralph Smith
Tomash, pp 506, $46*

P. V. Danckwerts

WHEN in 1947 J. Robert Oppenheimer read a draft of David Hawkins's report on the history of the Los Alamos Project (then titled LAMS-2352 "Secret") he remarked "darkly" to the author that he surely knew how to walk on eggs. The report was declassified and published in 1961. Now it is called "Toward Trinity" and is reprinted as Part 1 of *Project Y*, the second volume in the misleadingly-named "The History of Modern Physics 1800-1950". There was nothing particularly "dark" about Oppenheimer's remark; Hawkins has simply suppressed almost all the clashes of policy and temperament which made Los Alamos such a lively place to live in during the development of the atomic bombs in 1943-45.

Hawkins, an academic philosopher and Oppenheimer's administrative assistant, seems to have gone about writing his official history by consulting the records and asking people what they did. The result is predictably bland. To be sure, the technical account is no doubt impeccably correct as far as it goes, and indeed it contains some fascinating details which are new to me, but there is little about tantrums and threats of mutiny. The administrative details about mail, laundry, schools and so on are not gripping, but it is interesting to read that a farmer was paid $1350 in compensation for loss he suffered in selling 140 head of cattle at reduced market value because their hair was discoloured by exposure during the Trinity atomic test.

The site of the Los Alamos laboratory, which was the sharp end of the Manhattan Project (the American atomic bomb project), seems to have been the result of a trade-off between Major General Leslie R. Groves, in overall charge of the project, and J. Robert Oppenheimer, the director designate of the laboratory. Oppenheimer wanted as little compartmentalisation and application of the "need to know" principle as possible; he encouraged formal and informal discussions between scientific staff down to the middle levels.

Groves retaliated by choosing an almost inaccessible site which would discourage free intercourse with other parts of the project. Los Alamos was many pot-holed miles from the nearest rail and air terminals. The staff were subjected to travel restrictions and even the most senior were not allowed to fly.

Another consideration in Grove's mind was that the site was remote from invasion or raids on either coast, which seemed a possibility at the time. As a matter of fact, as we now know, one of the options which Hitler considered in the event of a successful invasion of England was an attack on the US via Mexico. In this case Los Alamos would not have been well placed.

Recruiting and keeping scientists and labour of all grades was a continual problem; there was a nationwide shortage. Despite bonuses, not everyone wanted to live on top of an extinct volcano in a mountainous wilderness, and there was a continual turnover of staff. Housing was a major problem because the number of people employed (about 2500 in mid-1945) was many times that originally envisaged. The scientists, and particularly those of sufficient seniority to see the whole picture, were naturally more highly-motivated than the machinists who knew nothing.

The procurement of materials and equipment was equally difficult. Despite the priority AA-1 given to the project, transport problems and security requirements made life hell for the procurement officer. All supplies had to be "laundered" through such places as Chicago and Los Angeles. The lack of contact between those specifying articles and those supplying them led to much frustration—for example, a little boron in some component might render it useless although it might seem irrelevant to the procurement officer. Every purchase required about 60 pieces of paper.

A similar problem arose with personal bank accounts. Most personnel initially had accounts at a bank in Santa Fe, under the name of the business manager, J. D. Muncey. It was the second largest account in the bank, and Muncey frequently received circulars from charitable organisations suggesting large contributions. Later the money

*Tomash Publishers, PO Box 49613, Los Angeles, CA 90049, USA. Add $2 p&p.

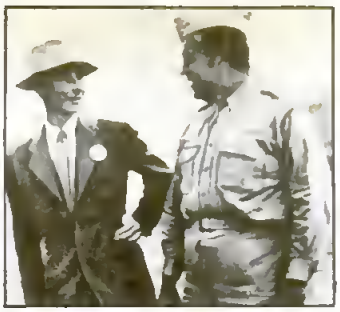
REVIEW

was dispersed into personal accounts via Los Angeles. Insurance created another security problem.

The obsessive concern with security must have retarded the development of the bomb by at least several months. I wonder whether it was all worth while. I presume that during 1943 it must have become clear to Allied intelligence that the Germans were not in the race. The Russians were the villains, but the name of Klaus Fuchs turns up on p 4 of this book as one who had been involved in British work on the bomb before June 1942, and he joined the Los Alamos staff early in 1944.

I assume that the Russians had people equally well placed in the isotope-separation and plutonium-production work, and that Stalin had good reason to be impassive when Churchill told him at Potsdam that "we" had tested an explosive of unprecedented power. Possibly the Russians might have developed their own atomic bomb a lot sooner if they had not been completely committed to winning the war in Europe on their own terms. General Groves would have condemned this as dangerous talk, typical of a Limey.

Part II of the book, "Beyond Trinity", covers the period from 1945 (that is, the dropping of the two bombs and the end of the war) to the end of 1946 when the army relinquished its control of the laboratory. This was an extremely difficult time at Los Alamos. It was the big letdown. Oppenheimer resigned as director at the end of 1945. Many scientists wanted to get out as soon as possible. Others could not make up their minds. The unlucky young scientists who had been caught up by the draft and put into uniform, and subsequently formed into Special Engineer Detachments (SEDs) naturally wanted to be demobilised; theirs was an attitude of "complete apathy and indifference" once the war was over, and the same was largely true of non-scientific civilian personnel. They were fed-up with isolation, bad accommodation and semi-military discipline. As everyone knows, there are three ways of doing anything—the right way, the wrong way and the army way.



Oppenheimer and General Groves at the Trinity site, and Los Alamos with its high-security fences

In the spring of 1946 morale was so low that an order was issued to the effect that anyone who resigned after 1 September, 1946 would not be paid his fare home. This had the desired effect—the waverers made up their minds and left. Among the factors which persuaded people to stay were the mountain scenery, the climate—and the isolation! I remember that analogous motives were apparent when the UK Atomic Energy Authority began to staff-up Dounreay.

From late 1945 until early 1946 there was a severe water-shortage at Los Alamos. This had a devastating effect on morale and made operational work difficult. Supposing this had happened 6-12 months earlier, would the atomic bombs have been ready in time to pre-empt the bloody attack of the US forces on the home islands of Japan, tentatively planned for 1 November, 1945?

Several home-grown Britons figure in the book. Among them W. G. (Lord) Penney is mentioned without any indication of the contribution he made. J. L. Tuck is given some credit for what in fact was his crucial contribution to the implosion bomb. (Sir) G. I. Taylor gets his due: the American "work on the hydrodynamics of the implosion and the nuclear explosion was too formal and mathematical ... most of the simple intuitive considerations which gave true physical understanding came from conversations with Taylor". Anyone who was privileged to hear G. I. lecture on sailing or early aircraft will realise that he actually *felt* how fluids behave—his mathematics was a method of convincing others and getting inelegant numerical constants.

The technical story adds little to what has already been published. The reader will be struck, however, by the undramatic descriptions of *two* "criticality" accidents, in which supercritical assemblies of fissile material occurred and in each case led to a lingering death from radiation. These accidents occurred in September 1945 and May 1946; in the latter case the victim was the senior scientist in charge of critical-assembly experiments. In retrospect it seems incredible that the second accident could have been allowed to happen. Subsequent experiments of this sort were conducted by remote control.

However, there were other hazards at Los Alamos. Radiolanthanum (a man-made isotope) was used in implosion research, several hundred curies being incorporated in explosive lens arrays. Remote-control devices had to be devised to deal with this element. Polonium (used in bomb initiators) proved to be an elusive element which spread easily and led to personal contamination. Plutonium is an evil substance, the lethal dose probably being in the microgram range. Conventional explosives were treated in ways, such as machining, which ordnance authorities regarded as hazardous. The wonder is that the number of people who died as a result of experimental work could be counted on the fingers of one hand. A remarkably small price to pay for the incineration of several hundred thousand Japanese. □

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A leaf out of the biologists' book

Organisational systematics
by Bill McKelvey, *California UP, pp 510, £24*

Colin Patterson

I OPENED this book with interest and anticipation—a fat book on systematics and evolution, from a respected press, by someone I had never heard of. I was quickly mortified by finding that Bill McKelvey is a professor in the Graduate School of Management at UCLA. "Organisational" in the title is used in the management sense, meaning organisations with employees such as hospitals, unions and General Motors. So the book was in the wrong hands—it needed a management scientist not a biologist.

Yet on scanning through it, I found that the book is packed with biological theory and practice; the authors most cited in the index are the biologists Robert Sokal, Peter Sneath and Ernst Mayr, with Darwin close behind. I once lived through a management course, whereas few management scientists will have even that experience of systematics. So I stuck with the book, and was soon impressed by the efficiency with which McKelvey has soaked up the biological literature.

McKelvey writes "Organisational science now seems to be roughly where biology was around the beginning of the eighteenth century". He proposes to put some heart and modernity into his field by importing ideas from biology, in particular neo-Darwinian theory, and a theory and philosophy of classification (which he correctly sees as a prerequisite for scientific method).

Organisational Systematics is no catalogue or checklist of employing organisations, but is almost entirely theoretical. This is odd; it is as if Mayr's *Principles of Systematic Zoology* (1969) or Sneath and Sokal's *Numerical Taxonomy* (1973) had been written before Carl Linnaeus's *Systema Naturae* (1735). It means that McKelvey's book is bare of examples, for the language, the names of groups, is yet to be invented. The only examples that McKelvey gives of his proposals are based on a short review of ancient Mesopotamia in 10 000-1600 BC, which is about as far from General Motors as one could get.

McKelvey discusses the different schools of biological systematics, past and present, and chooses a combination of two, the evolutionary (for example, Mayr's) as an explanatory theory and an inductive method, and the numerical (for example, Sneath and Sokal's) as an operational method which could provide a deductive test of evolutionary classification.

This choice and its justification are debatable, but not without interest. Given that theory, McKelvey needs some equivalent of the species concept in biology. After reviewing ideas on species and speciation in biology, he settles on a species concept in which the gene-pool of biology is replaced by an analogous store of information, the "compool"—shorthand for the dominant set of competences held at any one time by the employees of a population of organisations. I'm glad I don't have to work with that concept, though McKelvey is justified in emphasising difficulties with the biological species concept, which we do manage to use.

Armed with a species concept, McKelvey sketches what a higher classification of organisations might look like in reviewing early Mesopotamia. The kingdom he proposes are "hunters" (still with us as "ma-and-pa grocery stores, mountaineering teams, small student organisations"—perhaps equivalent to prokaryotes in biology), "producers", "palaces" and "normatives", the last including education, religion and bureaucracy.

Apart from an exposition of techniques which have been used in numerical taxonomy, the rest of the book is concerned with applying neo-Darwinian theory in the world of organisations. McKelvey writes "The modern version of evolutionary theory seems to apply to organisations as well as *or better* than it applies to organisms" (italics added). Again, an interesting and debatable viewpoint on evolutionary theory, which McKelvey characterises as "an explanatory but non-predictive science". He says "the principal need for evolutionary theory is to explain how there came to be so many kinds of organisations". I suppose his book will succeed if it leads to yet another kind, Institutes of Organisational Systematics. Such success might be better explained by Parkinson's theory than Darwin's.

Yet I found the book interesting and thought-provoking as a sort of looking-glass view of biology. I doubt that many biologists will read it, but management scientists will surely be stirred up by McKelvey's conclusion that organisations evolve not by human purposefulness but by natural selection—the people only generate variation. □

Book notes

The Fifth Generation by Feigenbaum and McCorduck, (Review, 30 June, p 960), is published in Britain next week by Michael Joseph, price £9·95. Christopher Joyce in his review wrote: "As a tract, *The Fifth Generation* is effective. It exhorts in simple language, that is limpid even to the most computer-ignorant. It makes bold predictions about that most unpredictable of things; the future."

Before It's Too Late, reviewed last week by Christopher Meredith, is distributed in the UK for WCC by British Council of Churches, 2 Eaton Gate, London SW1W 9BL. □

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REVIEW

Access to science for the disabled

Science for handicapped children
by Alan Jones, *Souvenir, pp 217, £7·95, pbk £5·95*

C. I. Howarth

WITHIN one cover this book contains a lot of information which will interest any teacher or parent who faces, for the first time, the problems of educating a physically handicapped child. The first part is a brief discussion of the place of science in the education of such children, which will help teachers and parents to think about the problems involved. The second, much larger part, describes 75 simple experiments for the disabled pupil. Details of sources of materials, ideas, the commoner handicaps and some useful aids for the physically handicapped appear in three useful appendices.

Although the book may be useful to teachers and parents, it serves no other purpose. It does not contain any new ideas about developing science education for handicapped children, because it is not based on a deep analysis of the nature of science teaching or the problems of handicapped children.

For example, Alan Jones lists the skills and processes involved in science as:

Observing
Measuring
Practical and manipulative skills—making things
Communicating—writing, diagrams, recordings etc
Ordering and classifying and looking for patterns in events
Problems solving—cause and effect
Projects—open-ended thinking
Designing apparatus and experiments.

It is a list that could act as a mnemonic in designing science curriculum, but it does not bear careful scrutiny. The elements on the list are not comparable with each other and Jones ignores the relationships between them. For example, observing and classifying are closely related, while measuring is one form of manipulation.

The same superficial approach is apparent in the discussion of handicap. Nowhere does the author mention that handicapped people run a risk of becoming practically and intellectually dependent. This is a form of learned helplessness for which training in scientific thinking may be an effective antidote. Handicapped children are a much more varied group than normal children. Apart from the likelihood of learned helplessness, the problems of handicap tend to be specific to the handicap, or even to the child.

The 75 experiments described lack clear structure, logical progression or indeed rationale of any kind. Many of them appeared in Arthur Mee's *Children's Encylopedia*, presented in much the same spirit of wonder and excitement, and with equally little conceptual analysis. The fact that all the experiments have been tested with handicapped children is, of course, reassuring. This empirical "seal of approval" may be more important than any theoretical insights which might have been obtained from a more careful consideration of the nature of science teaching, of the intellectual and practical problems of the handicapped, or of the interaction between the two.

In the absence of such insights we should perhaps be grateful for the real benefits which *Science for Handicapped Children* will confer on a number of teachers and parents. But the rest of us will not be able to avoid a feeling of disappointment at an opportunity missed. □

For the man on the Morpeth omnibus

Komatiites
edited by N. Arndt and E. Nisbett, *Allen & Unwin, pp 526, £40*

J. R. Cann

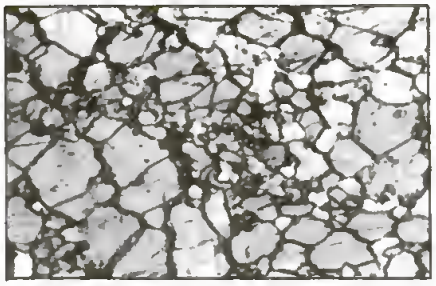
WHAT are the komatiites so baldly announced in the title of this new geological book? They are one of the newer tailismanic buzzwords which can contribute that extra gloss your paper so sadly needs. They are also an interesting class of volcanic rock, exceptionally rich in magnesium (18-30 per cent calculated as MgO), and characterised by strangely spiky radiating groups of needle-like olivine crystals up to 150 mm long. These groups bear a resemblance to spinifex grass, a spiky Australian grass that grows in the Western Australian drylands where komatiites are found. Nickel sulphide ores are often associated with them, and prospectors came to recognise spinifex texture as a guide to new deposits.

The name komatiite, though, comes from the Komati River that cuts through the Barberton Mountain Land of southern Africa. Here they turned up systematically as part of an Archaean (older than 2500 million years) sequence of lavas and sediments in a greenstone belt. Similar greenstone belts are widespread also in Western Australia, Canada, India and in most other Archaean terrains. Once attention had been drawn to komatiites, they began to turn up in older terrains throughout the world, and they seem to be a consistent feature of older greenstone belts.

This book is an introduction to the whole area. After an introductory section, there is a group of chapters describing komatiites from different parts of the world, a chapter on textures and two on alteration. Then comes a group on geochemistry, another on economic geology and a final section on petrogenesis. The editors have clearly taken a firm grip. The regional chapters are truly descriptive and stripped of the armouring of geological speculation that is increasingly and unnecessarily seen as part of every paper. Even the petrogenetic chapters are restrained and, in the best sense, Earthbound. The whole reads well and is generally at a very high standard (though not entirely so).

What are identified as the important insights from komatiites and problems in interpretation? First is the question of whether they were ever totally molten. Rocks of this range of compositions melt when dry at 1300-1600° C, much higher temperatures than normal lavas (1000-1200° C). Increasing magnesium content has a very marked effect on melting point of rocks. Several chapters address this point and the conclusions are drawn together by M. J. Bickle, who presents a very good case for liquids with as much as 25-30 per cent of Mg as MgO. This implies either very different melting conditions for komatiites, or the absence of some buffering part of a volcanic system that prevents such liquids being erupted normally.

Then there is the problem of young komatiites. The best known examples are very old, coming from a time when geological environments were very different from those we see now, but there are similar rocks from much younger times. The youngest seem to be those from Gorgona Island, in the Pacific near Colombia, described here by L. M. Echevarria, which are a mere 100 million years old. These are exactly comparable with the Archaean komatiites, and there are other occurrences that bridge the gap. It does seem, though, that komatiites are much rarer now than they were then. If we understood why, then this could tell much about the early geology of the Earth.



Komatiite-bearing rock in Ontario

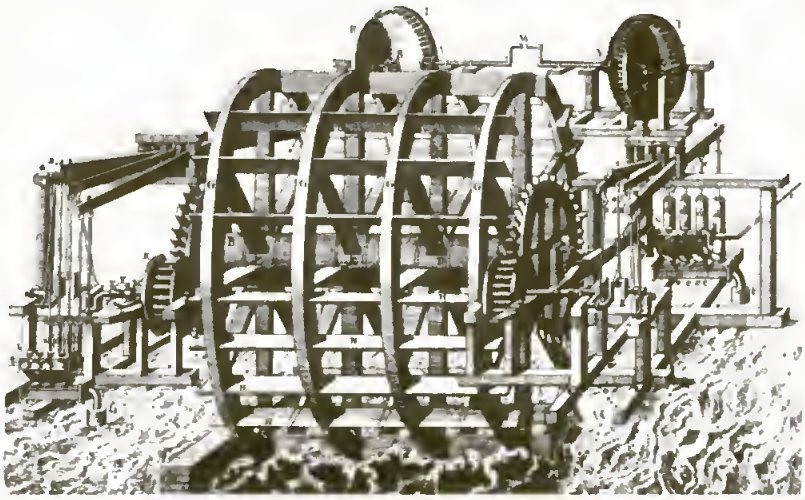
A clue to the answer seems to come from another kind of volcanic, boninites. These are lavas found (though not seen erupting) associated with the volcanic arcs of the West Pacific. They have characteristics that suggest a clear relation with komatiites, and similar rocks have been found erupted with komatiites (though not there called boninites for some obscure reason). Now the West Pacific volcanic arcs are places where the ocean crust is being subducted, carried back into the inside of the Earth. Could the komatiites be related to some kind of primitive subduction of ancient ocean crust? This could not be exactly like what we see nowadays because several of the most obvious characteristics are missing, but might be an earlier version of the same thing. If so, it might prove to be important evidence that plate tectonics and continental drift were happening already in the Archaean, something that most of us feel is likely, but difficult to prove.

All of these problems, and more, are touched on in this excellent introduction to the subject. The only difficulty with it is that it is very technical in a geological sense. Perhaps the *New Scientist* should ask one of the editors of *Komatiites* to write an article. That might help you, and also the ship navigating officer I sat next to on the bus to Morpeth, who had been reading over my shoulder, and eventually could not refrain from asking what on earth it was all about. It is for him that this review is written. □

Working with water wheels

Stronger than a hundred men
by Terry Reynolds, *Johns Hopkins UP, pp 454, £29·50*

Keith Sugden



Water wheel built in about 1700 for the London Bridge Water Works

BOOKS which expand from PhD theses tend to neglect the opportunity to present esoteric research to a wider audience. Although Terry Reynolds has developed his 1973 thesis into a detailed and definitive history of the water wheel, he sometimes misses the chance to explain how water power's many industrial applications made it such an important energy source.

The book's subtitle, "A history of the vertical water wheel", arises because the author excludes from his study the rare and puny horizontal water wheel which rotates in a horizontal plane about a vertical axis.

Reynolds traces the technology from the classical Mediterranean and argues that water power never caught on in the Roman Empire because of the reluctance of landowners to spend the necessary money. He suggests that exploitation of the traditional wooden water wheel gave Europe a medieval industrial revolution of equal importance to the more familiar revolution based on mass-produced iron and steam power. This interesting contention is supported by an admirable analysis of the high density of small English water mills recorded by the assiduous surveyors of the Domesday Book.

Reynolds further suggests that the less numerous medieval windmills developed their construction and gearing from the vertical water wheel.

It needs a writer with Reynold's long acquaintance with the subject to present an accurate account of the technical developments, and he is not afraid to reveal where he is unsure. Until about 1750 the archaeological evidence is scanty and the documentary evidence incomplete. This is not surprising: after all, the millwrights who built the wooden wheels were working in an oral tradition where they had no reason to record their methods on paper.

The author concludes his book with the proliferation of the breast-fed iron wheel designed by professional engineers who introduced an objective consideration of efficiency. Such wheels are familiar to industrial archaeologists from the many surviving examples.

Stronger Than a Hundred Men will appeal to anyone looking for reliable information on the development and construction of water wheels. Terry Reynold's fluent style and well-chosen illustrations make a technical subject accessible, while his copious but unobtrusive references will please the more serious student. There may be some readers who may feel, however, that a deeper discussion of what the water wheel was used for would have placed an important machine more firmly in its social context. □

Vivisection for the layman?

TELEVISION

Bernard Dixon

"IT SEEMS likely that, put together, results from several cell culture tests will add up to a profile of the product's hazard potential," voice-over Paul Vaughan said during **The Cruel Choice** (BBC2, 24 and 29 October). Over to Colin Muir of Leicester Polytechnic: "I wanted an experiment where I had a biological penetration barrier, and inside of that a biological um cellular system which could be affected by my test agents." And to Paul Turner of St Bartholomew's Hospital, London: "The distance between two carbon atoms may tell us that it's going to do something on blood pressure or something on salivation."

The commonest flaws in scientific popularisation are not the brandishing of jargon or the flaunting of polysyllables. Much greater problems arise from relatively ordinary language employed inelegantly, and from questions whose answers seem so *obvious* to insiders that they are neither confronted nor resolved. Defects of this sort are rare in the *Horizon* stable, so it was doubly surprising to find a profusion of them in this timely re-examination of so-called vivisection. Aside from Dr Muir's opacity and Professor Turner's looseness, the script bristled with awkwardness.

And with items like "endocrine abnormalities" left, unexplained, in mid air. We heard Professor James Bridges from the Robens Institute in Surrey saying, without amplification, that the LD_{50} test was "clearly inappropriate in many cases". An ICI expert stated that *obviously* "a chemical which works by being a hormone is not likely to work in a test which is only detecting effects which are genetic". Even DNA received peculiar treatment. Mentioned badly towards the beginning, it was defined as the chemical basis of heredity half an hour later. And there was a particularly sticky moment when someone described a cell line as a species. Ouch.

Explanations that *were* given tended to fly past at a rate of knots. I doubt whether many viewers unacquainted with the Ames test will have gathered much from this racy account of precisely how the test is conducted. And what might they make of Dr Francis Roe's portrayal of experimental mice as "laboratory artefacts"—beautifully clean and free of parasites but over-fed, desperately bored, and sexually frustrated by being kept apart from but within smelling distance of potential mates? Why raise them that way if such an unnatural lifestyle seriously impairs the significance of test results?

Another variety of question was prompted by a sequence showing work on the high pressure neurological syndrome (HPNS) suffered by deep divers. It was *obviously* too dangerous to experiment on a human being, Mr Vaughan said. Animals were essential. Which would have made sound sense had these comments not accompanied film of a human being climbing into an experimental diving chamber. And why, given that we understand the tremors, convulsions and death which characterise HPNS in mice, did scientists have to go on repeating such tests? Faced with some unpleasant footage and commentary, many viewers must have been troubled by unanswered anxieties at this point.

True, little of this would bother the readership of *New Scientist*. Indeed, I've no doubt that many readers will have enjoyed much of the programme. There were certainly moments to treasure. One came when the research director of Revlon dismissed as a "stifling approach to civilisation" the argument that we do not actually require new shampoos and face creams. He had in mind the appalling unhappiness and even marital disaster which could occur when a person became allergic to one of her (or his?) cosmetics.

But judging from its unrivalled record in illuminating science and medicine for BBC2 followers, *Horizon* is not addressed to *New Scientist* buffs—not primarily, anyway. This time, I fear, someone in Kensington House, London W14, overlooked that fact. □

This week's contributors

J. R. Cann is professor of geology at University of Newcastle upon Tyne.
P. V. Danckwerts FRS is emeritus professor of chemical engineering at University of Cambridge.
C. I. Howarth is professor of psychology at University of Nottingham.
Colin Patterson specialises in fossil fish at the Natural History Museum, London.
Keith Sugden is a writer specialising in the history of science.

Robot prices slashed

Standard components assembled in unconventional ways have cut 90 per cent off the typical price of a small robot. Cheap robots may create the unmanned laboratory

John Bell

PROPHESIES of large populations of robots in industry have yet to come true. For a decade or more, manufacturers of big robots—of a size capable of spraying large areas with paint or welding sheet steel, for example—have explained how their machines can make industry more competitive and productive. The market for big robots is now glutted and the impetus of the robotics revolution is claimed to be with makers of machines that handle a few kilos at most.

"Heavy-robot manufacturers are in some difficulty in finding customers. They are offering big discounts just to get in the door. There has been a disappointing growth everywhere in the numbers of robots, so we have to admit that we are either deluding ourselves or that the market is slow growing," John Reekie, chairman of Colne Robotics, told a meeting of the Institution of Electrical Engineers last week. "Three things must happen for the robotics revolution to occur. We must achieve widespread robot literacy; just as there has been a computer literacy programme there must be a robot literacy campaign. We must also achieve not just a cut in, but a collapse of robot prices. Finally, some kind of artificial intelligence needs to be available."

He, and others, believe that it is possible to reduce robot prices by 90 per cent by using standard components. If this happens then it will not only be industry that automates, laboratories will too. The unmanned laboratory is already being spoken about. A low-cost robotics "club" has been formed to give laboratory staff experience in working with robots and to experiment with applications.

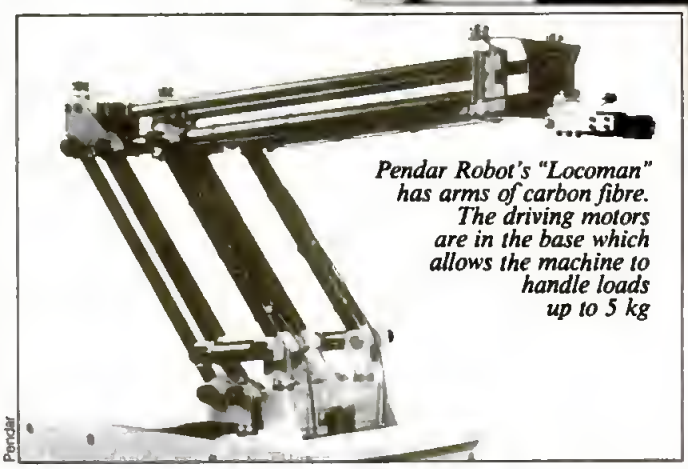
Colne, which is backed by Prutech, makes educational robots and machine tools. It is a tiddler compared to companies like Unimation, ASEA or Fujitsu Fanuc. But Colne and others—like Pendar, which makes robots in Wales, and departments in universities such as Surrey, Manchester, and Durham—possess an advantage over the giants. The big companies sell very expensive robots to businesses with expertise in automation. The little companies make robots for teaching people and now they have realised there is a need for small, low-cost robots that they can meet.

The little companies either bring their educational machines up to an industrial standard or design from scratch. One technique that they all adopt is to choose standard components where possible. Mike Novels, Pendar's sales and marketing director: "We are very much dependent on proprietary parts. The major cost of making both our models is the electronics. We can see that electronics will fall in price. There is less scope for reductions in mechanical costs. The use of proprietary parts, which are easily replaced, should give our robots a mechanical life of something in the order of five years."

Novels claims that it is possible for a Pendar robot to repay its cost in 18 months. This allows for a total installation cost of £24 000, including robot, its guards, tools, calibration and so on. The estimated annual savings are £16 000, evenly divided between increased production and reduced overheads. Novels's figures do not include any Department of Trade and Industry grant.

Pendar does not do its own basic research. Its robots are the result of work carried out at Surrey and Birmingham Universities. One of its machines is different to most because it is driven by pneumatics rather than electrics. The advantages of air-driven robots is that they are robust, tough and have a high power to weight ratio.

Jerry Mason



Pendar

Pendar Robot's "Locoman" has arms of carbon fibre. The driving motors are in the base which allows the machine to handle loads up to 5 kg

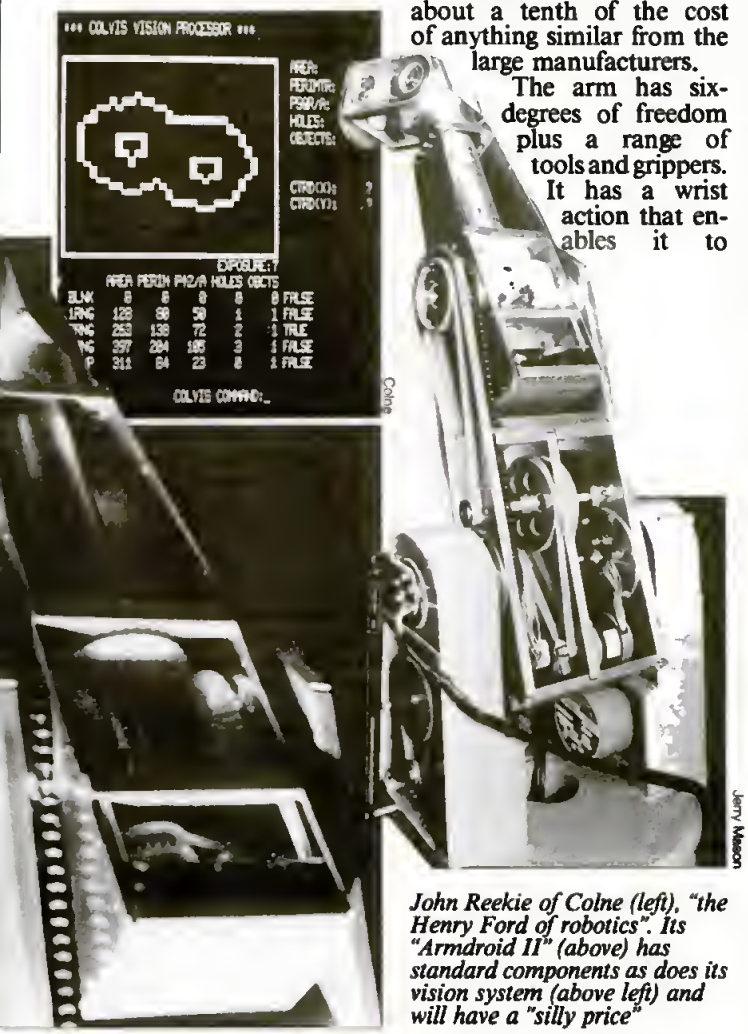
"There is no evidence that a robot should be more or less reliable than any other piece of automatic equipment," said Novels. "Robots should also be easy to teach. They should be programmable by shop floor personnel and not need a computer expert. We want push-button programming where possible."

If Pendar's motto is "cheap, tough, simple", then Colne would only add to it "and sold in a cardboard box". Reekie: "If we are going to achieve the collapse in prices necessary for mass sales then we must have robot literacy. Only then can

we divorce manufacture from application. The manufacturer has to be able to deliver a cardboard box to the customer who must have the ability to apply the machine inside it. Only then can we manufacture long runs of robots."

Colne announced last week the "Armdroid II", a "silly price" robot that, it says, could cut pay-back times to less than a year. The stand-alone arm is huilt with many standard components. These include ordinary hicycle chain and encoders usually found in computer printers. The price will be around £2000, about a tenth of the cost of anything similar from the large manufacturers.

The arm has six-degrees of freedom plus a range of tools and grippers. It has a wrist action that enables it to reach "under and back". The arm is designed to handle loads of two to three kilograms at speeds up to 180° per second.



John Reekie of Colne (left), "the Henry Ford of robotics". Its "Armdroid II" (above) has standard components as does its vision system (above left) and will have a "silly price"

The company has chosen to make a machine with relatively crude mechanics and to supply it with plenty of electronic controls and software that can run on most micro computers. The robot has seven Z80 microprocessors: one for each axis and a master, any micro can take on the master role. The difficulty of making the stepper motors (mass produced hy a video manufacturer) produce precise movements has been overcome hy encoding each axis rather than the drive.

Reekie, who has been tagged "the Henry Ford of robotics" for his views, says that his company's approach will "hring about a collapse in prices that will not be 10 per cent down, it will be a quantum drop. We will tackle the prohlem of artificial intelligence by the use of a cheap vision system".

If unconventional technologies succeed in collapsing the price of robots then these machines must, finally, be adopted by industry in large numbers. A massive reduction in costs will also create new applications, such as laboratory work, for these machines. The industrial "cluh", concerned solely with low-cost robotics, that has been formed includes the Laboratory of the Government Chemist, AERE Harwell and several household-name companies among its members. It receives money from the Department of Trade and Industry. The cluh has five groups. It is working so far, on two projects.

One project is concerned with weighing, the other with measurement. The first handles up to 60 samples of fermentation hroth automatically every day. A measured sample is centrifuged, decanted and dried before weighing and the results recorded in a microcomputer. The second project measures *p*H. It moves instruments and samples automatically through seven steps.

Laboratories tend to have concentrations of skilled people who are highly paid and spend a lot of time in routine work. Peter Matthews, who organises the low-cost robotics cluh, said: "The unmanned laboratory does not yet exist but there are a number of people thinking about the prohlems which it may present. The level of technology in laboratories is at about the same level as in the well equipped factory in 1979." A few years ago factories had centres of automation. Now rohots carry materials between work stations. "The progression from local to full automation has taken a major step forward for one reason—the recent advances in low-cost rohots. The British initiative in this area has been unique."

Matthews believes that robots, wherever they are, can only work at their full potential if the work that they do is understood better than the machines themselves. "There will be difficulties in the applications of robotics in the laboratory as there have been in the factory," he said. "One of the main ones is that the product, be it an engineering device or a chemical sample, will be expected to change to suit the robot's capahility as the robot and its technique will be modified to suit the production system."

Matthews gives the huge number of reagents used in analytical chemistry as an example of a practice that would need to change. Chemists can cope with this choice of chemicals hut it would be wasteful of computer time and memory to keep the variety in a robot system.

"To make no changes in method and practice to cope with robotic automation would seem to be unreasonable," said Matthews. "On the other hand most chemists will want to use methods that have served them well during their working lifetime. It is probably on this question of acceptance and flexihility of attitude that the new world of automated laboratories will mainly depend."

The other question, of course, is how great a change will be hrought about hy low-cost robotics? A lecturer in robotics from Durham University, George Carter, told the meeting that he expected work practices to shift dramatically. "Many human operators can beat the robot at its own game," he said. "In general robots are significantly slower than people and the machine has to pick up during the tea and pee hreaks."

Carter thinks that there is still teaching joh to be carried out before automation can become widespread. "A lot of good work has come out of universities in developing robotic devices, but where they teach computing and control they have often left out manufacture. Education must get into the act quickly to fill in that knowledge gap.

"One very important aspect of robots in education and training is the study of automated manufacture and how robots will change significantly the way in which components and assemhlies are made. The introduction of the true robot into manufacturing is creating a revolution, in that a whole new concept of manufacturing has to be thought through and applied. A manufacturer who buys a robot can end up buying a whole factory."

If Durham University's experience in placing students in jobs is typical, then industry is eager to learn about robotics. Carter: "Durham students, and I don't think Durham is exceptional in this, who study flexible manufacturing systems, receive an average of three job offers at salaries up to £15 000. One chap had seven offers, hut I think he was hanging about a hit. It pays to be a FMS student these days." □

LETTERS

Radiation complacency

John Dunster, director of the National Radiological Protection Board, seems dangerously complacent when he asks "Are we too frightened of radiation?" (13 October, p 70). Historically we have been proved repeatedly not to have been frightened enough. Although the medical effects of radiation in Joachimstal, Czechoslavakia, had been recorded for centuries, Marie Curie died of radiation cancer through lack of fear.

Medically, the researches of Alice Stewart and colleagues showed that radiographers, doctors and patients were insufficiently afraid of radiation. Now we find that lack of fear during the atom tests may have caused the deaths of soldiers and civilians from Utah to Japan and Australia. I believe we will find that those tests have contaminated the entire Earth.

Dunster states that ionising radiation is part of the natural environment and we do not quarrel with that statement's accuracy. But since around 1940, radiation and cancer statistics have been distorted beyond our understanding because, for example, we do not know enough about the hiosphere and the food chain, to know how much more dangerous the situation is than Dunster complacently believes.

Linda M. Hendry
Scottish Campaign to Resist the Atomic Menace
11 Forth Street
Edinburgh

* * *

The article by John Dunster seems very woolly-minded. In attempting to be all things to all men he leaves us very much up in the air.

No one can disagree with the statement that the NRPB has a responsibility to give a balanced view on the importance of the effects of exposure to low-level radiation, hut one is left with the impression that the NRPB does not know just where to draw the line.

In these circumstances the best policy is to come down on the side of caution. The alternative course could produce results which cannot be corrected.

J. Powell
Denton
Manchester

Greek quakes

I was baffled hy Costis Stambolis's report on earthquake prediction (*New Scientist*, vol 98, p 359) and the work of the VAN group. And being a physicist I feel ohliged to comment on some weak points in the article.

It is mentioned that the key feature of the new earthquake prediction method is the piezo-electric effect. This is not so. The key feature, as the VAN group maintains, is a kind of piezo-stimulated depolarisation current ich is superimposed on the uric currents. But while that ct can readily be observed in a oratory with a perfect crystal, y geologists think that its existence in rock formations of different structure and composition cannot really be accepted. On the other hand, the VAN group has not excluded with a sound method the ionospheric influence that is undoubtly present.

As for the "VAN box", although the always secretive VAN group never disclosed more details, it is believed to be nothing more than an amplifier combined with several high- and low-pass filters.

The prohlem, however, lies in the facts that your correspondent failed to mention. All the predictions were announced after the earthquakes, while all relevant papers were published only by the Athens Academy and not by recognised geophysical journals. In fact, as far as I know *Tectonophysics* and *Nature* did not accept for publication the work of the VAN group, while a 1982 communiqué signed by the heads of the Greek seismological institutions insists that the work is not at all original.

Finally, the claim that 400 seismic events have been successfully predicted since March 1981 cannot be confirmed, not only because the VAN group never cooperated with the estahlished seismological institutions of Greece, hut because the VAN recordings do not accompany the papers published so far.

P. Alevantis
Physicist-journalist
Encyclopædia Papyros-Larousse-Britannica
Athens

Pet subjects

James Serpell's piece about pets ("What have we got against pets", 13 October, p 80) raises important ethical, as well as scientific questions, particularly for those who wish to convince us that the interests of non-human animals are necessarily subordinate to our own interests.

Ambivalence towards pets because of their ambiguous status within society is perhaps best illustrated by the fact that we treat animals of broadly similar mental capacities in radically different ways. Some we choose to cosset and over feed, but we feel no compunction about confining others in factory farms and depriving them of those needs that we can readily identify in our pets.

The selection of species for their various fates seems to be entirely culturally defined, which explains the distaste commonly expressed in this country at the consumption of horse flesh and dog meat.

It would seem that the "ultimate distinction between man and beast" has long since been undermined and it may be that our ambivalence towards non-human animals can best be explained in terms of a collective guilt complex. Of course, most of us choose not to examine too closely the inconsistencies in our attitudes toward animals because these can only be resolved by changes in lifestyle and diet.

Unfortunately, this is traditionally the point at which rational thought ceases and cultural myopia takes over. In this we are aided and abetted by those who exploit animals on our behalf: the factory farmers and vivisectionists.

Robin Askew
Vegetarian and Animal Rights Society
Bristol

So grooming pets is relaxing and may help people to avoid heart attacks. I wonder if this could be part of our genetic inheritance from the days when, like the other apes, our ancestors used to groom *each other*, a ritual related to the security of belonging to the tribe and a reassurance of the individual's place in the hierarchy. If so, it would seem to be worth investigating whether or not hairdressers and masseurs are also relaxed people who have a low incidence of stress-related disease.

Dr John Gribbin
Lewes
East Sussex

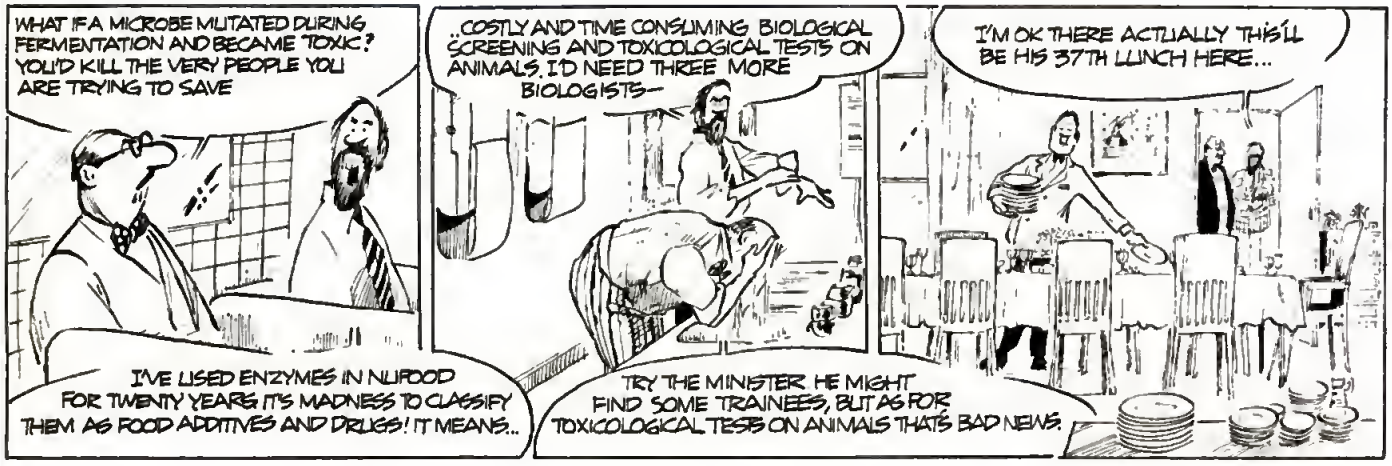
Food for thought

The James report exploded like a damp squib from the offices of the Health Education Council on 12 October to be greeted with derision hy journalists who had, previously, complained of its suppression by the government departments concerned.

Geoffrey Cannon (This Week, 20 October, p 160), and others, are husily castigating the DHSS, the government, the food industry and

GRIMBLEDON DOWN

Bill Tidy



any other available target. Surely they should, instead, be spending their time exploiting their talent to pass on to the general public the essence of the report for, if they do not do so, who will? After all it is "the puhlic's" diet which is to be changed if these proposals are adopted.

The public, unlike those august organisations, are not fools and will respond to well presented and easily understood information whieh tells them the "whats, whys and wherefores" of the proposed changes. We should not underestimate them or the power of the media to get the message across without the support of the government or the DHSS. The intelligent and dynamie journalist or health educator should not waste their time in castigation but should, instead, turn their attention to education. Many of the proposals depend not only on ehanges in manufacture and agricultural practice hut also on changes in public attitudes. So, while we're waiting for the former let's get on with the latter for, if we do it successfully, industry will have to ehange to meet puhlie demand and the role of government may well become irrelevant.

H. S. Holmes
Leatherhead
Surrey

Smoking tests

The report hy Ed Harriman (This Week, 20 October, p 159) on the determination of tar yield of British cigarettes by the Laboratory of the Government Chemist is inaccurate and misleading.

The procedures used have been accepted for 13 years as relevant for the intended purpose and confirmed internationally. The tests employed by the laboratory result from a joint agreement between the industry and government based on advice from medical experts, industry representatives and the Government Chemist. The test methods employed are essentially similar to those used by the Federal Trade Commission in Washington, differing only in minor details.

The tar yield obtained from cigarettes by these procedures is not an absolute parameter hut it has been derived in a standardised way whieh gives reproducihle figures for ranking cigarettes presently on the UK market. Continuity and reproducibility for test methods are important and 11 years of published information and retrospective testing of older samples is availahle. These results demonstrate trends in the reduction of tar yield over the years.

Although the principles of the tests have remained constant, substantial improvements in operational procedures and end-determinations have been developed in the laboratory, collaboratively tested with the industry and statistically validated, to ensure the cost effective monitoring procedure takes account of improvements in tecbnology. Recently the laboratory provided data on the carbon monoxide yield from cigarettes to supplement that on tar and nicotine.

I believe the current methodology furnishes a reliable means of ranking cigarette brands and is adequate for the publie wishing to ehoose between hrands on the basis of tar, nicotine and carbon monoxide yields.

R. F. Coleman
Laboratory of the Government Chemist
London

Creepy idea

Further to the correspondence on bathwater spin and associated matters (Letters, 20 October, p 218), I am wondering wbether, in their sober moments, Paul Dawson and C. Wilson have noticed the pbenomenon I have named "Picture-creep"? This describes the gradual tilting upwards of the right-hand side of a picture frame hanging on the wall, to give an anti-clockwise turn. The most careful alignment to the horizontal does not prevent this tilting, noticeable in only a few weeks.

Do those in the Antipodes experience "Picture-creep" in a elock-wise direction? Is this evidence of "spin" in the vertical plane?

Betty Boucher
Woking
Surrey

Cancerous evolution

The relationship between cancer and the mechanism of evolution has been well estahlished (J. Graham, *Journal of Theoretical Biology*, vol 101, 657). The source of genetic variation, essential for evolution to occur, lies in the rate of mutation of genes. The Ames test, employed by the United States Food and Drug Administration to estimate carcinogenicity of foodstuffs, uses this principle. Bacterial mutation rates are measured in the presence of a suspect foodstuff. Higher rates than normal are considered to be indicative of a carcinogen.

In recent years, theoretical studies have suggested two principle models for the pattern of evolution; phyletic gradualism and punctuated equilibria. Williamson (*Nature*, vol 293, p 437) inferred the latter in molluscan evolution, involving a period of little change in sbape, followed by a sudden diversification and further stasis. Despite recent reinterpretations, the only serious objection to this model is the absence of a mechanism to provide a rapid increase in the mutation rate of genes.

Williamson proposed genemutator complexes in discussing his study of Turkana molluscs. Researcb by Ames (*Science*, vol 221, p 1256) has suggested a significant alternative. This work shows that many dietary components decrease the mutation-related damage to cells. Dietary antioxidants, including vitamins C and E and B-carotene, prevent the formation of oxygen radicals and lipid peroxidation, whicb are significant causes of mutation.

Thus, a tentative link can be shown between environment (the nutritional balance of the diet) and mutation rate, providing a simple and widely applicahle mechanism for effecting punctuational evolution.

Graham B. Wilson
Department of Geology
University of Bristol

Vetting procedure

May 1 correct one error in Dick Lane's article entitled "Professional bloat" (Forum, 20 October, p 212). In this article it is stated that "the Royal College of Veterinary Surgeons (RCVS) controls the numbers of persons in the veterinary profession. The annual student intake of the veterinary profession is set at about 335..."

Although the student intake is correctly recorded, it is incorrect to state that the RCVS controls it. When the Report of the Committee of Inquiry into the Veterinary Profession (known as the Swann Report) was published in July 1975, it recommended that the manpower needs of the profession should be officially reviewed and reported on at intervals of approximately five years. It further recommended that "the agriculture departments should take the lead, in consultation with the University Grants Committee, the organisations representing the profession, and other interested organisation in conducting the periodie reviews".

This was precisely what was done, and the first Manpower Review was completed in 1980 with the conelusion that "the intake of students into veterinary schools in the United Kingdom in the academic years 1980/81 to 1984/85 should remain at about 335 a year".

It is of some importance to recognise that entry into the veterinary profession is not controlled by the profession's own governing body.

A. R. W. Porter
RCVS
London

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Interviews held locally

Scientific Staff Consultants

SSC SCIENTIFIC STAFF CONSULTANTS

50 Lincoln's Inn Fields, London WC2

OIL EXPLORATION LIBYA (Tripoli)

Tax Protected Salaries

We have been retained by Mobil Oil Libya, one of the foremost companies in the Libyan Oil Industry, to recruit the following personnel for their Tripoli head office.

Senior Geophysicists

Job Ref ML/1

To apply you should hold a BSc in Geology or Geophysics and have a minimum of five years experience of interpretation work.

Senior Production Geologist

Job Ref ML/2

Applicants should be qualified to BSc level in Geology and have sound practical experience in reservoir engineering, simulation and modelling.

Senior Explorationist

Job Ref ML/3

You should hold at least a BSc in Geology and be experienced in leading an exploration group.

Senior Staff Geologists

Job Ref ML/4

Candidates must be qualified to degree level in Geology and have at least ten years experience.

BENEFITS

All the above positions carry an excellent employment package and are both single or married status. Benefits include 35 days annual leave with air fare paid to point of origin, free furnished accommodation, free medical attention, free local education or education allowance and a relocation allowance. 90% of net salary is transferable. Salaries which are negotiable according to experience and qualifications will be discussed at interview.

Please write or telephone for an obligatory application form, quoting job reference number.

Irrelevant applications will not be answered.

JAWABY OIL SERVICE

UMM AL-JAWABY OIL SERVICE CO. LTD.
Recruitment Co-ordinator, Job Ref. ,
33 Cavendish Square, London W1M 9HF.
Telephone 01-499 0855

Senior Pathologist

Internationally respected as a leading name in the field of ethical pharmaceuticals, Smith Kline & French operates an intensive and innovative research programme. This new appointment within an expanding team is an opportunity for a man or woman with ambition, initiative, flair and drive to make a significant contribution to our programmes.

We are looking for a person whose experience of the pathology of laboratory animals is coupled with an interest in investigative pathology and the capability to integrate clinical factors in evaluating drug toxicity. Ideally we want a veterinary or medical graduate and desirably an appropriate research background. It is essential that the person is eligible for or has already obtained MRCPath.

There is considerable scope involved; the position will be styled to match individual abilities and experience, and research in applied areas will be encouraged. It is a challenge which could interest both experienced pathologists wishing to expand their fields of involvement and also those who possess the basic skills and want to enhance their career potential by participating in an expanding activity.

The rewards are commensurate with our reputation. There is an attractive salary and a full range of company benefits including company car, free BUPA, bonus plan, contributory pension scheme, free life insurance and flexible working arrangements.

Please write for an application form or send a detailed c.v. outlining qualifications and experience, quoting Ref. NS/955/T to T. E. Forster, Personnel Manager.

SK&F

SMITH KLINE &FRENCH RESEARCH
The Frythe, Welwyn, Herts AL6 9AR.

COMMONWEALTH AGRICULTURAL BUREAUX

Applications are invited for the post of

ENTOMOLOGIST

in the

COMMONWEALTH INSTITUTE OF BIOLOGICAL CONTROL

The Commonwealth Institute of Biological Control is one of the four Institutes and ten Buresux which together comprise the Commonwealth Agricultural Bureaux, and provide a comprehensive world-wide information service in agriculture and related fields.

The CIBC undertakes research and carries out projects on a contract basis from its bases in India, Trinidad, Kenya, Pakistan, Switzerland and UK. It also provides an information and advisory service in all aspects of biological control and on the development of integrated post management programmes.

With the increasing interest in biological control world-wide, the CIBC is expanding its programme. It is intended to establish 'task forces' on each continent and, to build up the team in the Caribbean and South America, an additional entomologist is required at the West Indian Station in Trinidad.

The appointment will be made within the salary scale £7149-£9561 with the starting salary according to qualifications and experience. Applicants should have a post-graduate degree with some proven interest in biological control.

The appointee will be expected to qualify in Spanish at a language school before taking up the post. While the officer will be based in Trinidad, he/she will be expected to travel widely in the course of duty. While the Institute has, in the past, been concerned solely with classical biological control, projects involving integrated control programmes will figure prominently in the future and so the appointee will be expected to develop and maintain an expertise in such programmes for certain major world crops.

Further information is available from:

The Assistant Director,
Commonwealth Institute of Biological Control,
Imperial College,
Silwood Park,
Ascot,
Berks SL5 7PY, UK.

Tel (0990) 23911 Telex 847964
Cables Comag, Slough

to whom applications, including a CV and names and addresses of two referees, should be submitted by 31 December, 1983.

Southampton THE UNIVERSITY

PARALLEL COMPUTER DESIGN

Applications are invited for a two-year research assistantship to design and implement a parallel computer architecture in silicon. This SERC funded project will be held in the Physics Department here but will have support from an existing VLSI architecture group in the Electronics Department.

Candidates should have relevant postgraduate or research experience. Part-time registration for a higher degree may be available. Salary in a range up to £8530 per annum plus USS benefits.

Applications (in duplicate) giving a brief curriculum vitae and the names of two referees should be sent to D. A. S. Copland, The University, Southampton SO9 5NH, quoting reference 200/R/NS.

WEST LAMBETH HEALTH AUTHORITY
ST. THOMAS' HOSPITAL, LONDON SE1

SENIOR GRADE PHYSICIST
DEPARTMENT OF MEDICAL PHYSICS

Applications for the above post are invited from those with experience in Radiatioo Physics. Preference will be shown to those candidates wbo also have experience in computing and electronics.

The duties of the successful applicant will be principally concerned initially with radiotherapy treatmeot planning, dosimetry and the developmeot of oew techoiques. Individual project work will be encouraged and the ability to pursue such projects to a successful completion is required. The post may also require work in other areas of radiation physics with which the department is involved.

The department is situated in s modern building with oew equipmeot and extensive laboratory and workshop facilities.

Enquiries regardiog the above post should be made to Mr W. F. Clapbam or Mr J. E. Saunders in the Medical Pbysics Departmeot, Ext: 2374.

Applicatioo form and Job Description are available from the Personnel Officer, St Thomas' Hospital, London, SE1 Tel: 01-928-9292 Ext: 2779.

Salary Scale: £9010—£11 649 pa +£997 London Weighting Allowance. Closing date for completed applications 14 November, 1983.

UNIVERSITY OF NEWCASTLE UPON TYNE

Department of Agriculture

DEMONSTRATOR

Applications are invited for the post of Demonstrator in the Department of Agriculture. Candidates should hold a good Honours degree in Agriculture or related disciplines and preferably an appropriate post-graduate qualification. The Demonstrator will have special responsibilities for the collection and presentation of physical and financial farm data and for the organisation and conduct of field classes. The successful candidate will also be expected to participate in the teaching and research activities of the Department according to expertise and special interests.

The post is tenable for three years. Salary will be at an appropriate point on the Orade 1B (Bar) scale: £6310–£8530, according to age, qualifications and experience.

Further particulars may be obtained from the Deputy Registrar (FP), The University, 6 Kensington Terrace, Newcastle upon Tyne NE1 7RU, with whom applications (three copies), together with the names and addresses of three referees, should be lodged not later than 18 November, 1983. Please quote reference NS.

Plant Physiologist – Plant Tissue Culture

Greenford, Middlesex

is required for the Fermentation Section of Biotechnology Department, to grow a diverse range of plant species as callus tissue to investigate the potential of plants as a source of biological activities. The successful applicant will develop and implement a variety of culture conditions on the growth of plant cells to maximise the synthesis of secondary metabolites.

Candidates should have a degree, and preferably a PhD, in an appropriate biological discipline. Experience in plant suspension culture and plant genetics would be an asset.

The Company offer excellent conditions of employment including, non-contributory pension scheme, bonus schemes, subsidised canteen and an active Sports and Social Club.

Please send in a CV or telephone for application form to: The Senior Personnel Officer (MRKK), Glaxo Group Research Limited, Greenford Road, Greenford, Middlesex UB6 0HE. Tel: 01-422 3434 extension 2706 quoting reference number U/506.

Glaxo *Group Research Ltd.*

THE UNIVERSITY OF MANCHESTER
RESEARCH ASSISTANT IN MICROBIOLOGY

Applications are invited for an MRC-funded post which is available for an investigation into the ability of streptococci to induce dental caries under challenge from competing micro-organisms. The appointee must have a mature attitude to research, be capable of fitting into an existing research team, and have at least an upper second class Honours degree. A suitable appointee would be able to register for a higher degree. Salary range £6310 to £8530 pa (Superannuation) dependent upon age, qualifications and relevant experience. Further particulars may be obtained by writing to Dr D. B. Drucker, Department of Bacteriology and Virology, Stopford Building, Oxford Road, Manchester M13 9PT.

UNIVERSITY OF EDINBURGH
DEPARTMENT OF CLINICAL CHEMISTRY

Postgraduate Research Associate

Applications from Honours graduates in Biochemistry or a related discipline are invited for work on a project designed to assess the clinical value of human hepatic glutathione S-transferase measurements in the adult and the neonate.

The post is funded by the Scottish Home and Health Department and is tenable for one year in the first instance (University salary scale 1B).

For further information and arrangements to visit the laboratory contact Dr G. J. Beckett or Dr J. D. Hayes (031-229 2477 Ext 2395). Written applications with CV and names of two referees to **The Secretary to the University, Old College, South Bridge, Edinburgh** within three weeks of the appearance of this advertisement.

Please quote Reference No 5128

Biochemist

A vacancy for a Biochemist has arisen within our Biochemical Services Unit which is based at our Chemotherapeutic Research Centre, Brockham Park, set in rural surroundings yet near Dorking and within easy travelling distance of London.

Biochemical Services carry out biochemical work on anti-bacterial agents in conjunction with other research and development groups within the company. The present areas of work involve studies on biosynthesis of antibiotics, the biochemistry of beta-lactamases and beta-lactamase inhibitors and the biochemical properties of new penicillins.

The successful candidate will be working within the group studying the biosynthesis of antibiotics, so should have a Ph.D. or good Honours Degree in biochemistry and have had several years' experience of enzyme assays (including HPLC) and enzyme isolation procedures. Apart from a sound biochemical knowledge, a broad knowledge of organic chemistry is also required in order to liaise effectively with the other members of the group.

The company will offer a competitive starting salary along with other fringe benefits associated with a large international organisation. These benefits include a non-contributory pension scheme, free life assurance, flexible working hours, a subsidised staff restaurant and excellent sports and social club facilities.

If you think you meet the requirements and would like to apply, please write, enclosing a C.V. to:-

The Site Personnel Manager, Beecham Pharmaceuticals Research Division, Brockham Park, Betchworth, Surrey RH3 7AJ.

Beecham
Pharmaceuticals

KING'S COLLEGE SCHOOL OF MEDICINE AND DENTISTRY
(University of London)
Denmark Hill
London SE5 8RX

MEDICAL LABORATORY SCIENTIFIC OFFICER (RESEARCH)

Applications are invited for a two year appointment as Medical Laboratory Scientific Officer in the Department of Anaesthetics. This is an MRC funded project to study the physiology of chemoreception. Experience in biochemical techniques would be an advantage. Salary on the scale £6488 to £6693 pa.

For further details contact Dr J. Ponte on 01-274-6222 Ext 2012. Applications, quoting Ref CA/TI and including the names and addresses of two referees, should be sent to the Secretary of the Medical School by 18 November, 1983.

UNIVERSITY OF SHEFFIELD
DEPARTMENT OF ANATOMY AND CELL BIOLOGY

TECHNICIAN GRADE 3–5

Required for duties mainly in Electron Microscopy and experience in this field is desirable. Candidates should possess at least an ONC/TEC in a relevant subject. Salary on the scale £5151 pa–£7332 pa, depending on age and experience.

Applications, giving the name of two referees, to: **Administrative Officer (Personnel), Services Department, University of Sheffield, Sheffield S10 2TN,** quoting reference number S 1821.

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Graduate Toxicologist

based near Cambridge

. . . to join our team of toxicologists involved in the safety evaluation of pesticides.

Initially you will ba trainad to supervisa the conduct of acute studies but at a latar data you can expect to control the execution of other types of study. In addition you will retrieve, review and prasent information from published literature and internal reports.

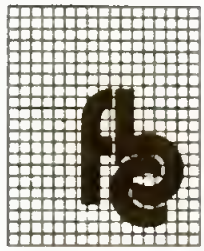
In the ege range 21-25, you will be a recent graduate in toxicology or have a toxicology-biasad degree. You must be able to damonstrata good organisational ability and a logical approach to problam solving. Relavant practical experience, which may heve bean gained via e sandwich course, would be an advantage.

You will be besed at our Research Station near Saffron Walden which is 15 miles from Cembridge.

This appointment is open to both men and women.

We offer a competitive salary supported by a substantial range of fringe benefits normally associated with a major internetional company, including ralocation expenses, where appropriate.

Please write, quoting refarance number CP690, giving full datails of your career to date including current salary, to: Peter England, Personnel Officer, FBC Limited, Chesterford Park Research Station, Saffron Walden, Essex CB10 1XL.



Quality Assurance Manager

Redhill, Surrey

Redland Roof Tiles, a major company within the international Redland Group, is the foremost manufacturer of roof tiles in the world. We have a high reputation for providing quality and service to our customers which we intend to maintain.

We are looking for a Quality Assurance Manager to run the quality control operation at our 12 U.K. tile works. This is done through two Regional Controllers and Quality Controllers at each site.

The scope of the job involves quality input from the product design side right through to the customer. In addition the job will involve the setting up of product specifications and quality schemes for the U.K. and for some Redland works overseas.

The prime requirements are proven ability to manage and motivate people at widespread locations, coupled with an ability to analyse problems and identify the resources needed to resolve them. In addition you should have a degree/HNC or equivalent in engineering or materials/physical sciences with some years' experience in high volume continuous process production or quality assurance. Experience in the building materials industry will be useful but is not essential. Previous involvement with statistical methods will be an advantage.

The position reports to the Production Process Manager and carries excellent employment benefits and a company car. Some travelling in the U.K. is to be expected with occasional trips overseas.

If you wish to apply, please write with a full c.v. or telephone for an application form to David Wilcox, Personnel Manager, Redland Roof Tiles Limited, Redland House, Reigate, Surrey RH2 0SJ. Tel. Reigate 42488.

Redland
ROOF TILES

THE POLYTECHNIC OF NORTH LONDON
Department of Food and Biological Sciences
GRADE 3 LABORATORY TECHNICIAN (TEACHING AND GENERAL)

Applications are invited for the above post.

The person appointed would be required to assist with the preparation of three teaching laboratories, especially the Materials Science laboratory, under the direction of the Grade 6 Technician.

Preparation of practical classes in the laboratory areas, including checking and replenishing of items regularly required for laboratory practicals. General maintenance and servicing of standard apparatus and construction of minor items using basic skills.

Applicants should be suitably qualified OND or ONC or two 'A' levels or Ordinary City & Guilds or equivalent, and should have had at least three years experience in a similar post (including training period).

Salary scale: £5151–£6036 plus £1220 London Weighting.

Application form and further particulars obtainable from The Establishment Officer, The Polytechnic of North London, Holloway Road, London N7 8DB.

Closing date for the receipt of applications: 14 days from the appearance of this advertisement.

UNIVERSITY OF EAST ANGLIA

School of Chemical Sciences

A postdoctoral research fellow is required to work with a group of organic chemists and spectroscopists preparing novel organometallic dyes for use in fluorescent solar collectors. Applications are invited from persons having experience either in organic synthesis or in optical spectroscopy, especially luminescence. The appointment is for one year beginning as soon as possible after 1 November, 1983. Salary will be on the RA(1A) scale which begins at £7190 pa.

Applications with a curriculum vitae together with the names and addresses of two referees should be sent as soon as possible either to Dr M. J. Cook or to Dr A. J. Thomson, School of Chemical Sciences, University of East Anglia, Norwich NR4 7TJ.

THE UNIVERSITY COLLEGE OF WALES ABERYSTWYTH

TECHNICIAN POSTS (MICROBIOLOGY)

Applications are invited for the following temporary (three-year) appointments in the Department of Botany and Microbiology.

Technician (Grade 3): Microbial Genetics
Technician (Grade 5): Microbial Physiology

The appointees will join a research group studying biotechnologically important fermentation processes in anaerobic bacteria. To commence 9 January 1984; salaries on the scales £5151 to £6035 and £6279 to £7332 pa respectively. Application forms and further particulars from the Registrar, (Staffing Office), The University College of Wales, Old College, King Street, Aberystwyth, SY23 2AX, (Tel 0970 3177, Ext 207). Closing date for applications, Thursday 1 December, 1983.

THE ROYAL FREE HOSPITAL

SYSTEMS DESIGNER/ PROGRAMMER

Salary Scale 9: £9364—£11 274 pa inc.

The Department of Chemical Pathology, Royal Free Hospital, has a Wang 2200 MVP system running BASIC-2, which provides a computerised laboratory reporting service. A Systems Designer/ Programmer is required to be responsible for the system and for all aspects of the service provided by the Department, this will include training and supervision of junior staff.

The successful candidate will be responsible for the day-to-day management of the system and for ensuring that the implemented applications continue to run smoothly. They will also be required to develop the system—either by the edaption of existing programs or by the design of suitable programs to provide an improved laboratory reporting service. There will also be an opportunity to further develop a Z80 based communications Controller and to undertake other microprocessor based projects.

Applicants should possess an appropriate degree or equivalent qualification. Two or more years experience involving some or all of Wang 2200 systems, BASIC, PASCAL and Z80 Assembler is assential. Knowledge of medical laboratory working practices would be a distinct advantage.

For further information, informal enquiries should be made to Ms Eva Arnold on 01-794-0500, Ext 3305.

Application form and job description available from the Personnel Department, Royal Free Hospital, Pond Street, Hampstead NW3 2QG. Tel 01-794-0500, Ext 4286.

Please quote ref: 1201.

Closing date: 18 November, 1983.

HAMPSTEAD HEALTH AUTHORITY

HEAD OF INSULATION LABORATORY

up to c £15,000 p.a.

We have an excellent opportunity for an electrical engineer/ materials scientist to lead a small team of technologists engaged on electrical insulation problems and applications of new polymers and other materials. For more information please telephone (0785) 43366 (24 hrs) or 43178 or send a C.V. in confidence quoting ref 215/INS to Engineering Management Selection, FREEPOST, Stafford ST17 4BR.

Engineering Management Selection

VG SCIENTIFIC LIMITED

The Surface Science and Microscope Company

ANNUAL EXPANSION

VG SCIENTIFIC is an established company in the field of Surface Analysis and Scanning Transmission Electron Microscopes. We are the largest manufacturers and exporters of this sophisticated instrumentation in Europe. Our instruments are installed in the R&D laboratories of many of the world's major semiconductor, oil and chemical companies, as well as many universities. We have been very successful over the past several years and have continued on this path in 1983 despite the world recession. We now wish to recruit the following staff to continue growth in 1984.

HI-TECH SALES/MARKETING ENGINEERS

Suitable candidates could be research scientists (graduate or post graduate with personality and drive for technical marketing. A knowledge of Vacuum, Surface Physics (Esca/Auger/SIMS) or spectroscopic techniques would be an advantage. The appointment will involve six-eight weeks international travel per year in the role of technical/sales support for local field sales agents. Major markets for our products are USA, Japan, China and Europe.

Remuneration includes a good salary plus company car and benefits shown below.

TEST/DEVELOPMENT ENGINEERS

To work on surface analysis instrumentation (XPS, AES, SIMS) and/or scanning electron microscope systems.

Experience of UHF techniques and electronic fault finding would be an advantage.

Successful applicants will be required to spend some time travelling both in the UK and abroad (typically for two-three week periods).

DEC RSX11M ANALYST/PROGRAMMERS

For program design and development in our Systems Development Department.

The successful applicant should have had at least two years practical experience in real time systems using RSX11M MACRO 11 and PASCAL.

We are offering competitive salaries, Sickness and Pension Scheme, Free Life Assurance, generous holidays and relocation expenses where necessary.

Please apply to **Mrs R. Wiseman, Personnel Officer, VG Scientific Ltd., The Birches Industrial Estate, Imberhorne Lane, East Grinstead, Sussex. Telephone: East Grinstead (0342) 25011.**

Product Management – Hospital Products

Career growth in dynamic new venture

These two new appointments call ideally for young greduates or equivalent qualified in life science, technical or para-medical subjects, now seeking e career move into e young, fast moving business whose turnover is already approaching eight figures. The task will be to make e positive and creetive contribution to accelerating growth in a business which is backed by the resources of a major international group.

Responsibilities will be for developing and implementing an innovative marketing stretegy embrecing market and new product development, pricing, promotion and peckeging.

A successful record of selling hospital or closely related products linked to product/brand management is essential. One appointment as **SENIOR PRODUCT MANAGER** (ref. AQ.75278/A) calling for candidates in their late twenties/eerly thirties carries e selary negotiable to £13,000 plus car; the second appointment as **PRODUCT MANAGER** (ref. AQ.75278/B) calling for a minimum age of 24, carries e salery negotieble up to £10,000.

Benefits in line with best large compeny prectice. Bonus. Generous relocation help. Career prospects linked directly to business growth.

Please write – in confidence – stating how you meet the requirements, quoting the appropriate reference, to E. I. Clark.

These appointments are open to men and women.

HAY-MSL Selection and Advertising Limited,
Union Chambers, 63 Temple Row, Birmingham B2 5NS.

Offices in Europe, the Americas, Africa, Australasia and Asia Pacific.

HAY-MSL

MANAGEMENT SELECTION

HONOURS GRADUATES

"The truth is rarely pure and never simple" Oscar Wilde

Discerning fact from fiction is never an easy job. Tax Inspectors have to use perception and persistence to unravel the complexities of business accounts and identify any irregularities.

Through intensive training you will develop the skills of a lawyer, advocate, accountant, investigator, negotiator and manager. You will become capable of examining the accounts of businesses ranging from small shops through to £multi-million organisations, agreeing their tax liabilities, detecting fraud, and negotiating settlements with taxpayers and their financial advisers.

Within a few months you can expect to be handling your own casework, involving many face to face interviews. After 3 years you will be managing a sizeable team of staff and, in due course, you should be running your own tax district.

Qualifications: Under 32 and a degree with at least second class honours or an acceptable equivalent qualification. Final Year Students may apply.

Starting salary £5785-£7980 according to experience. You should be earning £8780 after 2 years and £12395 3 years later. Within 10 years you should be on a salary scale rising to £20790. In another 5 years you could be on a scale rising to £23155. Beyond this there are opportunities for further promotion to the most senior grades in the Civil Service. SALARIES HIGHER IN LONDON. Training can usually begin at an office in the area of your choice.

To find out more and for an application form write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours).
Please quote ref: A/320/172.

BRISTOL POLYTECHNIC
Engineering Department

RESEARCH ASSISTANT

Ref. No. R/137

Salary Scale:
£5415-£6123 per annum

Applications are invited for the post of Reseerch Assistent, to join e team of developing regeneretive flywheel drives for energy storage epplications.

Applicants should preferably have an honours degree in en engineering discipline. Recent experience with computer based instrumentation would be an advantage.

The post is for two years commencing January 1984.

For further details and an application form, to be returned by 18 November, 1983, please contact the Personnel Office, Bristol Polytechnic, Coldharbour Lane, Frenchay, Bristol or ring Bristol 656261, Ext 216 or 217.

Please quote Reference Number R/137 in all communications.

SCIENTIFIC OFFICER
(Senior Physicist Scale with London Weighting)
To fill a vacancy in the Marie Curie Research Wing for Oncology, Regional Radiotheraphy Centre, Mount Vernon Hospital, Northwood, Middlesex. Medical Research Council Programme Grant "The clinical testing of methods to improve radiotheraphy, particularly those sensitizing hypoxic tumour cells"
The successful candidate will give support to the clinical research programme, in particular to the collection, storage and analysis of clinical data using a dedicated computer and also to the monitoring of tumour response and to the introduction of new techniques such as hyperthermia. A full-time basic grade physicist is in post.
Further particulars and arrangements to visit may be obtained by writing Dr S. Dische or by telephoning Northwood 26111 Ext 533.

A Bigger Career Choice in Medical Sales

If you have a scientific or paramedical background and want to succeed in a commercial environment leading to a managerial role, then phone Andree Osborne or Alistair Ross now on 01-222 1547.

Ross Warren Recruitment

Director of Research

Racal Electronics plc is primarily involved in the field of professional electronics and services with sales in the financial year 1982/83 of 763M.

The Data Communications Group represents approximately 30% of this total and consists of three major operating companies: one based in the U.K. and two in the U.S.A. It is a leader in the exploitation of the worldwide telecommunications network for data communications and is now developing into an all digital environment.

Within this Group, a new company has been formed – Racal Information Technology Developments Ltd. Located in the Thames Valley, it will combine three major activities – applied research, strategic marketing and business development.

The Director of Research, who will report to the Managing Director, will control a team which will supplement the existing design activities within the operating companies by carrying out work in related fields. The expectation is that the results of this research will be either passed on to the operating companies for further development or may form the basis of a new company should this seem appropriate.

The Director appointed will possess a good first degree and almost certainly a second degree in an appropriate field.

Experience may have been gained in a number of different areas including digital communication systems, signal processing, telephone or data switching, computer system architectures etc. Whatever the speciality, the successful applicant will necessarily be experienced in the application of advanced software tools and skills.

He/she will be an active innovator who also possesses the necessary interpersonal skills to communicate at any level within the Group.

In addition to a highly attractive salary, participation in executive level benefits including the provision of a company car, the person appointed will also have the enviable opportunity to build his/her own team to work within what must be one of the most challenging sectors of the electronic industry.

Please write with full details of career and qualifications to: R. I. Melrose, Personnel Manager, Racal Data Communications Group, Landata House, Station Road, Hook, Hants. RG27 9JF.

RACAL

INSTITUTE OF ORTHOPAEDICS
Brockley Hill, Stanmore, Middx HA7 4LP

LECTURER IN CELL BIOLOGY

Lecturer in Cell Biology urgently required for Department of Biomedicel Engineering. Successful candidetes will be s member of interdisciplinary team studying e variety of materials for use in orthopeedic surgery. Willingness to teke part in colleborstive rsseerch end development work with industry essentiel. Applicants should hold PhD in e biological subject snd must be sxperienced in scenning electron microscopy. Preference will be given to those with knowledge of microbiology snd/or tissue culture. Sslery on University of London Scales for Non-clinical Academic staff plus London Weighting will depend on ege, qualifications end experience.

Applicetions (forms from Institute Secretary, Institute of Orthopeedics, Brockley Hill, Stanmore, Middx (Tel 01-954-2300, Ext 31B) required by 25 November, 19B3 with cv.

CHAPMAN AND HALL **E. AND F. N. SPON**

The Scientific Division of ABP (UK) Ltd

EDITORIAL MANAGER

We have a vacancy at the head of our book subediting section. The position involves overall responsibility for the management of copy-editing and proofreading activities for approximately 60 technical manuscripts each year. Previous experience in the copy-editing of scientific, technical or medical manuscripts is essential.

Please apply with CV and current salary details to:

Mr D. J. E. Richards,
Personnel Director,
Associated Book Publishers (UK) Ltd,
11 New Fetter Lane,
London EC4P 4EE

HNC/HND in Chemistry?

Pesticide R&D will interest you

Synthesising new pesticides is challenging work. Due to continuing expansion in this area, we at Shell Research Limited have additional posts available immediately for Organic Chemistry Technicians to work on the synthesis of novel biologically active compounds.

If you are qualified up to the HNC/HND level (or equivalent), or have wide experience in chemical synthesis, we would like to hear from you.

We offer a competitive salary and assistance will be given with relocation expenses where appropriate. You would be based at our Research Centre situated in pleasant rural surroundings near Sittingbourne and within travelling distance of several residential areas.

You will be able to join our pension scheme, enjoy flexible working hours and make use of the excellent sports and social facilities.

Please write for an application form to:

Mrs. M. A. Newton, (PNS/3) Personnel Division, Shell Research Limited, Sittingbourne Research Centre, Sittingbourne, Kent ME9 8AG.

The closing date for all applications is November 17, 1983.

Please note, if you applied to this advertisement earlier this year, your application will automatically be reconsidered.

Shell

CRANFIELD

Computer Methods in Fluid Flow

The Department of Fluid Engineering and Instrumentation at Cranfield has interests in flowmeter design and development, and in the practical and theoretical analysis of steady and transient flow through pipes, pumps and compressors. Good honours graduates in engineering, applied mathematics or science subjects are needed to fill the following vacancies in the research team.

RESEARCH OFFICER for work on computational techniques for the analysis of internal flows in compressors. Ideally, candidates should have a research degree, with experience in fluid mechanics and/or computing. Appointment for three years, with salary in the range £7190-£9425 and opportunity to register for a higher degree. Ref: 1.

RESEARCH OFFICER to assist with industrially based research projects connected with the analysis of flow and in the management of supporting computer services. Computing experience, preferably in industrial fluid mechanics, is needed, together with empathy with the small team of disabled engineers who provide additional skills in computing. Appointment for three years, with salary in the range £7190-£11 615. Ref: 2.

RESEARCH ASSISTANT to work in any of the Department's areas of interest. The successful applicant may undertake a conventional MSc or PhD degree, or may choose to extend the one-year MSc to two-years part-time, using the additional period to develop skills in computation by assisting on various research contracts in the Department. Two-year appointment, with salary in the range £6310-£8530. Ref: 3.

Requests for an application form and further particulars, specifying the post in which you are interested, should be addressed to: The Personnel Department, Cranfield Institute of Technology, Cranfield, Bedford MK43 0AL; Tel Bedford (0234) 750111 Ext 3336.

JOHN INNES INSTITUTE

SCIENTIFIC OFFICERS (two) required for two years (with a possibility of extension to three years) to join groups working on micropropagation and genetic manipulation of sugar beet through tissue culture. The successful applicants will work under the direction of senior scientists.

1) Department of Applied Genetics (Ref AG.152) to work on morphogenesis in sugar beet tissue culture.

2) Department of Cell Biology (Ref CB.153) to work on preparation and culture of sugar beet protoplasts.

Minimum qualifications: Degree in a relevant subject.

Salary on the scale £5682-£6313, rising by four annual increments to a maximum of £7765. Non-contributory superannuation.

Applications, quoting the appropriate reference, giving full particulars and the names of two referees should be sent to the Secretary, John Innes Institute, Colney Lane, Norwich NR4 7UH, not later than 23 November, 1983.

DEPARTMENT OF CHEMISTRY

POSTDOCTORAL RESEARCH POSITIONS

Applications are invited from well qualified candidates for one or two year appointments as Postdoctoral Fellows or Research Associates in all fields of Chemistry.

The minimum stipend for one year will be $16 560. Type of appointment and stipend will depend upon qualifications and experience. Several teaching appointments are open to applicants who have recently graduated and show superior ability in research and scholarship.

Candidates should forward enquires to the undersigned for further information:

L. Weiler
Professor and Head
Department of Chemistry
2036 Main Mall
University of British Columbia
Vancouver, British Columbia
Canada V6T 1Y6

In accordance with Canadian Immigration requirements, this advertisement is directed to Canadian Citizens and permanent residents.

UNIVERSITY OF STRATHCLYDE

Department of Physiology and Pharmacology

RESEARCH ASSISTANT

Applications are invited for a two year Research Assistantship to study the affects of *B. pertussis* infection on serum insulin and glucose concentration, on a joint project with the Department of Microbiology, University of Glasgow and Ruchill Hospital. Applicants should be graduates in Pharmacology or Physiology.

Salary on the Range 1B of the national salary scale for research staff (£6310—£8530 pa). USS benefit.

Applications (two copies) with the names and addresses of three referees should be sent to Dr B. L. Furman, Department of Physiology and Pharmacology, University of Strathclyde, George Street, Glasgow G1 1XW (quoting ref: R39/83) from whom further particulars may be obtained. Closing date of applications: 2 December, 1983.

Senior Chemist

for a programming role in our Molecular Graphics Section

Middlesex based

We seek a Senior Chemist to work on the development of software techniques to meet the needs of project groups within the Company's Chemistry Divisions at Ware and Greenford. There will be involvement in the fields of graphics, chemical computation and structural molecular biology. The work will lead to useful predictions of 3-dimensional structures, structure activity relationships and drug-macromolecule interactions, as well as the establishment of structural data bases.

The successful candidate will manage the Section's VAX 11/750 and Megatek graphics installation and will be responsible for the introduction of new graphics hardware.

Applicants should have a PhD degree and, probably, post-doctoral research experience. He/she must have a background involving the application of computers in chemistry, crystallography or molecular biology. Experience with graphics would be desirable, but is not essential.

Starting salary will be within the range of £8,000 per annum to £11,000 per annum, including London Allowance. In addition, there are bonus schemes and a non-contributory pension scheme. Assistance with relocation costs will be given where appropriate.

Please send a CV or telephone for an application form to:— The Personnel Officer (REN), Glaxo Group Research Limited, Greenford Road, Greenford, Middlesex UB6 0HE. Tel: 01-422 3434 extension 2573 quoting reference number AQ/450.

Glaxo *Group Research Ltd.*

UNIVERSITY COLLEGE LONDON
Chemistry Department
POSTDOCTORAL POSITION IN PHYSICAL CHEMISTRY

Applications are invited for a post-doctoral position funded by the Department of Industry for the study of vapour pressures and critical properties of organic compounds. The programme will be in collaboration with Dr D. Ambrose and will involve experimental measurement and the assessment of other data. The appointment will be from November 1983 (or as soon as possible thereafter) for one year with a possible extension. Salary will be within the RA 1A scale between £7190 and £8530 pa plus £1186 London Allowance, according to age and experience.
Applications as soon as possible, with curriculum vitae and the names of two referees to: Professor M. L. McGlashan, Department of Chemistry, University College London, 20 Gordon Street, London WC1H 0AJ.

UNIVERSITY OF NOTTINGHAM
Experimental Parasitology Unit
Department of Zoology
POST-DOCTORAL RESEARCH ASSISTANT

required for MRC-supported project concerned with genetic control of eosinophil responses to parasitic infections. The work will involve *in vitro* culture of lymphocyte and bone marrow cell populations and relevant experience is desirable. The post is available immediately, starting salary between £7190 and £9875 (according to age) on the University 1A scale. Applications with CV and names of two referees to Professor D. Wakelin, Department of Zoology, University of Nottingham, University Park, Nottingham NG7 2RD.

Information Scientist

Howson-Algraphy are world leaders in the manufacture of Lithographic Printing Plates.

An opportunity currently exists in our modern Research and Development Department for an individual to join our small professional team of Information Scientists.

Ideally, applicants aged 20 to 27 should have a degree in Chemistry, plus a further qualification and/or experience in Information Science, although consideration will also be given to suitably experienced Information Scientists, not academically qualified. A working knowledge of a foreign language would be an advantage.

Job responsibilities will include the selection and abstracting of information for an in-house computerised information retrieval system; searches of patent and journal literature, and development of information services.

Conditions of employment are first class.

Written applications should be addressed to: —

Sandra G. Bateson, Group Personnel Assistant, Vickers plc, Howson-Algraphy Group, Coal Road, Leeds LS14 1NA.

Howson-Algraphy

A Vickers company

ST MARY'S HOSPITAL MEDICAL SCHOOL
(University of London)
Norfolk Place, London W2 1PG
Department of Medical Microbiology (Virology)
RESEARCH ASSISTANT/ MEDICAL LABORATORY SCIENTIFIC OFFICER

required to work for one year on a WHO-funded project to develop immunoassays for specific orthopoxvirus antibodies. Applicants must have prior experience in virological and/or serological techniques.

Applicants must be state registered MLSOs (salary scale up to £6126 pa + London Allowance) or graduates in microbiology or immunology with minimum two years' post-graduate experience (salary up to £7190 + London Allowance). Enquiries to Dr J. D. Williamson (Tel 01-723 1252 Ext 237). Apply with full cv and names and addresses of two referees to Assistant Secretary (Personnel) at above address by 14 November quoting Ref A/JDW.

UNIVERSITY OF MANCHESTER
Department of Pharmacology
TECHNICIAN

required to assist in teaching and research in the laboratories of this Department, situated in the Medical School. Minimum qualifications ONC and at least three years experience in a biological or chemical field.

Salary scale £5151-£6035 pa.

Applications with details of qualifications, experience, age and the names of two referees to the Departmental Superintendent, Department of Pharmacology, Medical School, University of Manchester, Oxford Road, Manchester M13 9PT.

Marconi Space and Defence Systems at Portsmouth is one of the country's leading electronics companies As specialists in military, civil and defence communications we pride ourselves in the depth of experience and expertise within our systems engineering group

Workload is such that the group is being greatly expanded creating a range of posts up to Principal Systems Engineer level Tasks cover the full spectrum of conception, design and implementation of communications systems Specific areas of current interest include digital switching and transmission, including satellite communications and all aspects of planning complex systems involving traffic, signalling and routing

A good degree and several years relevant experience is essential as is the desire to make a successful contribution to the group Overseas travel will obviously be involved

Salaries and benefits will reflect the calibre of engineer we wish to recruit

Communications Systems Engineers

Telephone (0705) 674019 for an application form Alternatively you can write to Jack Burnie, Marconi Space and Defence Systems Limited, Browns Lane, The Airport, Portsmouth, Hants PO3 5PQ quoting ref BL 131 (All posts are open to men and women)

Marconi
Space & Defence Systems

Marconi

CORNING

Development Chemist

Corning Medical's Instrument Development Group has a vacancy for a Development Chemist at its Sudbury location

The job is to be responsible for the development of ion selective electrodes for medical analytical instruments.

The opportunities for promotion within the Medical Division or one of our associated companies within the UK are good—as are the opportunities for successful employees to re-locate overseas within subsidiaries of our parent US Company, Corning Glass Works.

Applicants should posses at least a first degree in Chemistry, preferably a PhD. Experience in the field of ion-selective electrodes or biosensor technology would be advantageous.

Good rates of pay, promotional prospects, pleasant working environment and subsidised canteen are just some of the attractions expected from this major international company.

For an application form please write to, or call: Hugh A Newman, Personnel Manager, Corning Medical and Scientific, Northern Road, Chilton Industrial Estate, Sudbury, Suffolk CO10 6XD. Telephone 0787 76481.

CRANFIELD

RESEARCH ASSISTANT TO DEVELOP AN APPLICATIONS ORIENTED EXPERT SYSTEM FOR AIRCRAFT STRUCTURAL DESIGN

The College of Aeronautics, in partnership with a group of European based organisations, has won a contract under the EEC's ESPRIT programme to research and develop software for enhanced applications of Artificial Intelligence.

The work associated with this contract will require exploring the complex problem of transferring knowledge from the aircraft design framework into a form suitable for configuring a 'rule set' for an Expert System. A second task will involve examining the possibility of using finite element analysis methods to supply additional information to permit the Expert Program to augment the basic 'rule set' supplied by the design engineer. Extensive research will be required to surmount the difficulties associated with interfacing this type of major analysis program with the complex Expert System being devised by the partnership as a whole. The work will be suitable to allow the submission of a PhD thesis, subject to the normal conditions imposed by Cranfield Institute of Technology on students working for higher degrees.

The position requires a candidate capable of high level research with a background in aeronautical structures, finite element methods and some experience of software development. A strong ability in mathematics is essential, together with a good class honours degree in aeronautical engineering or equivalent.

Salary will be in the range £6310 to £8530 pa although a higher salary may be possible for an exceptionally well qualified candidate. Appointment will be for three years.

For an application form, please contact: The Personnel Department, Cranfield Institute of Technology, Cranfield, Bedford MK43 0AL; Tel Bedford (0234) 750111 Ext 3336.

UNIVERSITY OF WARWICK

POST-DOCTORAL RESEARCH ASSISTANTS

Two positions are available in the Department of Biological Sciences to work on an *in vivo* and *in vitro* study of microbial oxygenase-based bioconversion systems. This research is funded by a three year grant from the SERC Biotechnology Directorate with a view to understanding the fundamental mechanisms which will enable those microbial systems to be used in the production of value added oxygenated chemicals. A background in the use of computer-controlled fermentation systems would be an advantage for one of the positions and a working knowledge of enzyme regulation, microbial physiology/biochemistry or oxygenase enzymes would be preferable for the second position. Such positions will have a technician associated with the work and the successful candidate will be expected to collaborate with each other on most aspects of the project. Starting salary up to £8530 pa on the Research 1A scale: £7190–£11 615 pa. Applicants should send a cv with the names and addresses of two referees to Professor H. Dalton of Biological Sciences, University of Warwick, Coventry CV4 7AL by 18 November, 1983. Informal enquiries and further particulars from Professor Dalton 0203 24011 Ext 6025.

TOXICOLOGISTS

The Boots Company is expanding internationally in its quest to discover and develop new medicinal products. Accordingly, the Research Department is seeking to appoint experienced toxicologists at STUDY DIRECTOR and STUDY SUPERVISOR levels. Eligible candidates will already know the impeccably high standards of expertise and judgement required to fill these demanding roles.

In addition, new vacancies have arisen for good honours GRADUATES in appropriate biological disciplines with the ability and the motivation to be trained in toxicology.

The benefits are those associated with a large successful Company and include profit sharing and staff purchase privilege. Generous help with relocation to the Nottingham area is available if applicable.

Candidates for the Study Director and Study Supervisor positions should forward a detailed curriculum vitae whilst candidates for the graduate position should write or telephone for a personal data form to: Mr. T. W. Flower, Employment Manager (Technical), The Boots Company PLC, Station Street, Nottingham. NG2 3AA.

The Boots Company PLC

Marine Biologist
up to £9999

Applications are invited for this post in the Authority's Tidal Waters Section at Bridgend, Mid Glamorgan

This section is a small, active multi-disciplinary unit carrying out a number of projects and offering a service across the Authority's area

Appointment to this post will be for a period of three years and the starting salary will reflect the experience which can be brought to the position. Applicants should be experienced graduates in marine biology and the work will be to undertake biological studies of Swansea Bay.

These studies will comprise a comprehensive study of the distribution of the benthic infauna and the factors affecting that distribution, a study of the productivity of selected species over the three-year period and the investigation of any anomalies observed. The postholder will be responsible for the detailed design, execution, interpretation and reporting of the biological work. The biological programme will be integrated into existing hydrographic modelling and water quality studies with the objective of producing a definitive report on the factors affecting the benthic infauna

Application forms may be obtained from:
The Assistant Personnel Officer
Welsh Water Authority
Cambrian Way
Brecon
Powys LD3 7HP
Tel: Brecon (0874) 3161 Ext 230

Please quote reference 536 when applying

Closing date for applications: 18 November, 1983.

WELSH WATER AUTHORITY
AWDURDOD DWR CYMRU

Royal Military College of Science, Shrivenham

Lecturer/Senior Lecturer Computing Science

This is an opportunity for a well qualified and experienced systems specialist to join the Computing Science Branch of the College. The work will involve teaching at undergraduate and postgraduate levels, principally in the MSc course in the Design of Information Systems. Inputs to shorter courses such as Real Time Systems Design and Microprocessors will also be required.

You will be expected to carry out research and development in appropriate fields, developing external contacts. As well as carrying out normal academic duties there will be opportunities to read for a higher degree if appropriate.

Computers currently in use include two DEC VAX 11/780s, a VAX 11/750, PDP-11/45 and Perkin Elmer 3200 on an interactive network. Languages taught and used include Pascal, Fortran, Coral-66, and BASIC.

Candidates must have a first degree in a relevant subject and a higher degree would be preferred. A minimum of four years computer science experience is required. Teaching experience would be an advantage.

Appointment will be as Lecturer (£5680-£7765) or Senior Lecturer £8970-£11,475) according to qualifications and experience. Starting salary may be above the minimum at each level. Promotion prospects.

For further details and an application form (to be returned by 25 November 1983) write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB or telephone Basingstoke (0256) 68551 (answering service operates outside office hours).
Please quote ref: S(C)908.

LABORATORY MANAGER

An expanding, international firm, we need an outstandingly talented but mature person to manage the operation of two of our laboratories.

Discipline is not so important as good down to earth management experience and unquestionably good qualifications in one or more branches of the physical sciences.

Further details of the job and very competitive package are available to suitable and interested candidates.

CV's in the first instance please, to BOX No. 1/JE/NS

ELSEVIER PUBLICATIONS (CAMBRIDGE)

SCIENCE EDITOR

Due to expansion of the responsibilities of the editor, an opportunity has arisen for the appointment of an assistant editor of our monthly review journal, Trends in Pharmacological Sciences.

The ideal candidate will have an educational background in pharmacology or a related discipline and some experience in academic or industrial research. Organisational ability, an eye for detail and the ability to work to deadlines are essential. Experience in publishing or editorial work is an advantage.

The post offers an interesting career opportunity in science publishing.

Salary will be based on age and experience.

Please send your cv and relevant details to:
Dr A. M. Grimwade, Elsevier Publications (Cambridge), 68 Hills Road, Cambridge CB2 1LA

CAREER OPPORTUNITIES FOR BRIGHT YOUNG DEVELOPMENT CHEMISTS

National Adhesives and Resins Ltd., a profitable subsidiary of a progressive multi-national organisation, are UK market leaders in industrial adhesives and resins.

As a result of our continued expansion, we need 3 Development Chemists to join our technical team, regarded as the key to the Company's future.

We are active in a wide variety of market applications and our Development Chemists quickly assume responsibilities for formulation, product assessment and production scale up. This means that in addition to proven technical expertise, you must be articulate and capable of creative positivity with a wide range of colleagues and customers.

We are looking for people who enjoy the 'practical approach' and have a good degree in chemistry or an associated subject. Some 2 years industrial experience, where you have been responsible for working to specific targets and can demonstrate problem solving ability, would be advantageous. A knowledge of synthetic polymers would also be helpful.

In addition to excellent prospects for advancement, we offer an attractive salary according to experience, and generous benefits including 24 days holiday, private health insurance and relocation expenses where appropriate.

Please write with career details to Jayne Prattis, Personnel Officer, National Adhesives & Resins Ltd., Galvin Road, Slough, Berks SL1 4DE.

National Adhesives

CLINICAL TRIALS STATISTICIAN

Warner Lambert is one of the world's major international research-based pharmaceutical groups. Its U.K. Medical Division, based in South Hants, has a vacancy for a Clinical Trials Statistician. The main purpose of this position will be to provide statistical advice and assistance in all aspects of clinical trial work, with special reference to phase IV trial design and analysis of results. This will involve liaising with the C.R.A.s on the planning of trials, collation and testing of data and preparation of reports; and with the Clinical Research Data Executive in the use of departmental computer facilities.

The person appointed (male or female) will have a degree in Statistics, a keen interest in Medical subjects and good communication skills. Some experience in a Clinical Trials Unit in industry or the N.H.S. is preferred.

The Company offers a salary of c. £8,500 depending on experience, plus other large Company benefits including bonus. Generous relocation expenses to the area are paid where appropriate.

Please send a full C.V. or ring for an application form to: Mrs. C. M. Cook, Senior Personnel Officer, Warner Lambert (U.K.) Ltd., Mitchell House, Southampton Road, Eastleigh, Hampshire, SO5 5RY. Tel. Eastleigh (0703) 619791.

Closing date for applications will be 21st November, 1983.

WARNER LAMBERT

THE UNIVERSITY OF ASTON IN BIRMINGHAM

Department of Modern Languages

RESEARCH FELLOW IN COMPUTATIONAL LEXICOGRAPHY

Applications are invited for a Research Fellow to work, under the direction of Professor F. Knowles, on the design and implementation of a computerised dictionary containing specialised vocabulary relating to computer science and to information science and technology. This dictionary is intended to be a monolingual (in this case, English) defining dictionary but it will also include lexical equivalences in German. The dictionary system is intended to demonstrate the greater effectiveness and efficiency of computerised visual look-up as against turning pages in a traditional hand-held dictionary. To this end the implementation must rely on the sophisticated use of relational database techniques.

Applications are invited for this SERC sponsored post from, preferably, graduate computer scientists with experience of or a strong interest in natural language processing. This Research Fellowship is available now and is scheduled to continue for two years in the first instance. The salary offered is £7630 pa.

Prospective candidates are welcome to contact Professor F. Knowles by Tel (021 359 3611 Ext 4212) if they wish to inform themselves more fully before applying.

Application forms may be obtained from the Staff Officer (quoting Ref 577/32), University of Aston in Birmingham, Gosta Green, Birmingham B4 7ET. (Tel 021 359 3611 Ext 4564). Closing date for the receipt of applications is 25 November, 1983.

THE UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH

DEPARTMENT OF AGRICULTURE

DEMONSTRATOR IN AGRICULTURE

Applications are invited for the post of Demonstrator in the Department of Agriculture. Applicants should have a good Honours Degree in Agriculture, Animal Production or Animal Science together with appropriate postgraduate experience. The appointment will be made according to qualifications and experience within the Range £6310-£8530, and the successful candidate will be expected to commence duties on 9 January, 1984 or as soon as possible thereafter.

Application forms and further particulars are available from the Registrar (Staffing Office), The University College of Wales, Old College, King Street, Aberystwyth, SY23 2AX (Tel 0970 3177 Ext 207). Closing date for applications: Monday, 28 November, 1983. Previous applicants need not re-apply.

UNIVERSITY OF OXFORD
University Laboratory of Physiology

Neurohistology Technician

Grade 5

Salary £6279-£7332

Applications are invited for this post. The work will involve the running of a histology laboratory and the use of methods in neurohistology, histochemistry, photography, electron microscopy and autoradiography for research on the nervous system. Experience in more than one of these techniques is essential.

Applications, stating age, qualifications and experience, and giving the names and addresses of two referees, should be sent to **The Administrator, University Laboratory of Physiology, Parks Road, Oxford OX1 3PT.**

Analytical Laboratory Deputy Head

Home Counties £8,000-£10,000

This vacancy represents an unusual opportunity to join the management team of the prestigious central technical laboratories of Associated British Foods, one of Europe's largest and most successful food groups. The Weston Research Laboratories, based near Maidenhead, provide a full advisory and monitoring service for quality assurance and product development for the group's manufacturing and retailing divisions. Following an internal promotion, the analytical section of the Laboratories now requires a Deputy Head to be responsible for the service provided to the manufacturing companies of the group, as well as to assist the Section Head in the general management of the Department. The main challenges of the position will be to organise, train and motivate a small graduate-level team to carry out a wide range of non-routine analysis as efficiently as possible and to liaise effectively with operational management, customers and suppliers regarding the interpretation of the results.

Candidates, aged 30 plus, should have a degree or equivalent in chemistry, sound practical knowledge of classical and modern instrumental analytical techniques, together with several years' experience of food and food ingredient analysis in either the commercial or public sector. Up-to-date knowledge of food legislation and labelling would be an added advantage. The benefits are those normally associated with a major group and career prospects are excellent. Relocation assistance will be considered as appropriate.

Applications with detailed cv should be sent to: The Group Personnel Officer, Associated British Foods plc, Weston Centre, Bowater House, 68 Knightsbridge, London SW1X 7LR.

MORAY FIRTH MALTINGS plc

are leading suppliers of malt to the Scotch whisky distillers and to brewers in the UK and overseas.

The Company will appoint a

Technical Manager

who will be based in Inverness and will report to the Technical Director or, in his absence, to the Managing Director. The responsibilities of the post are the quality audit and assessment of barley and the malting process, customer technical services and the necessary investigative research and development.

The successful applicant, preferable in the 30-45 age group, will be qualified in chemical and biological disciplines and have a background of achievement in the management of quality control and/or research and development in an organisation concerned with the processing of natural products. A knowledge of malt, whilst useful, is not regarded as essential in this appointment.

The salary will be in excess of £13 000 pa with excellent non-contributory pension arrangements. A company car will be provided. Removal expenses and legal costs of moving residence will be paid.

Application in the first instance should be made with full personal details to the Company. Interviews and selection will be conducted in association with Pollock and Pool Limited, Reading, who are advising the Company.

Moray Firth Maltings plc
Longman Road
Inverness IV1 1SL

Senior Scientist/ Engineer – Process Control Systems

SOLIHULL up to £11,112

British Gas is currently developing advanced control systems for future generations of Substitute Natural Gas plant. Computer control techniques for the automatic start-up, running and shutdown of full scale plant are being demonstrated. A Scientist/ Engineer is needed to join the Plant Automation Group based in the Controls Division at the Midlands Research Station to contribute to this important activity.

Areas of work covered include the development of computer control strategies, preparing process control software in liaison with process engineers, commissioning and evaluation of system performance.

The successful applicant will have a good honours degree in engineering or physics and at least one years' industrial experience, preferably in the field of computer process control.

The salary is from £6,136 to £11,112 per annum depending upon age and experience. An attractive package of benefit is included and relocation is available if appropriate.

Application forms can be obtained from:
The Senior Personnel Officer, British Gas,
Midlands Research Station, Solihull, West Midlands
B91 2JW, quoting reference MRS/446.

Closing date for applications: 17th November 1983.

BRITISH GAS

Jeunes Ingénieurs Chimistes

désirant être formés pour une carrière internationale

L'ORÉAL, un Groupe de renommée internationale dans le domaine des produits cosmétiques et capillaires, souhaite former trois jeunes ingénieurs chimistes de nationalité britannique.

Le premier sera affecté, pendant sa première année, à la filiale britannique dont l'usine est située dans la region de Cardiff. Ensuite, il prendra un poste pendant un an dans une des usines L'ORÉAL située dans le nord de la France, avant de revenir au Pays de Galles pour remplir une fonction de direction technique ou production.

Les deux autres seront confiés directement, pour une période de deux ou trois ans, à un poste de production en France. Ultérieurement nous envisageons de leur offrir des postes de direction à l'étranger.

Les candidats retenus auront reçu une formation en génie chimique; travailleurs, ambitieux, méthodiques et d'une certaine créativité, ils auront une aptitude naturelle pour les relations avec autrui. Ils doivent être prêts à se déplacer dans le monde.

Les lettres de candidature avec curriculum vitae détaillé sont à adresser à: B.J. Sullivan, General Manager, Human Resources, L'ORÉAL, 30 Kensington Church Street, London W8 4HA

L'ORÉAL

THE UNIVERSITY OF TASMANIA AUSTRALIA

CHAIR OF ZOOLOGY

Applications are invited for appointment to the Chair of Zoology in the Faculty of Science. The Chair became vacant on the retirement of Professor B. Johnson. Applications are invited from candidates in any field of Zoology though they should have an interest in or sympathy with whole animal biology.

The present professorial salary is $A46 977 pa which is expected to be increased by 4·3% as a result of the recent national wage decision.

Candidates who wish to apply should in the first instance write to the Registrar, University of Tasmania, Box 252C GPO, Hobart, Tasmania, Australia 7001, or to the Association of Commonwealth Universities (Appts), 36 Gordon Square, London WC1H 0PF, to obtain a detailed statement of the conditions of appointment and application forms.

Applications close on 31 December, 1983.

ASSISTANT CONSERVATION OFFICER

The Somerset Trust for Nature Conservation requires an Assistant Conservation Officer to assist the Conservation Officer with the practical management of the Trust's thirty-five Nature Reserves and in the provision of advice to private landowners and other organisations. The post will be on a three year contract in the first instance, grant aided by the Nature Conservancy Council. The salary will be £5500 pa.
Candidates should have a good honours degree in Biology, Geography or a related subject with practical experience of field surveys and conservation work. A full driving licence is essential. A vehicle will be provided.
Applications must be made on the form which is available on receipt of a SAE from the Somerset Trust for Nature Conservation, Fyne Court, Broomfield, Bridgwater, Somerset TA5 2EQ. The closing date for entries is Friday 25 November, 1983.

Stability/ Registration Analysts

Two recently qualified BSc Chemistry graduates for pharmaceutical manufacturer.

Stability Analyst

to organise and conduct stability programme.

Registration Analyst

To carry out some of the analytical work involved in the stability programme and assist with the documentation relating to product licence application and manufacturing through-put.

To apply please send C.V. to:
The Personnel Officer,

Regent Laboratories Ltd

Cunard Road,
London NW10 6PN.

SCOTTISH HEALTH SERVICE

COMMON SERVICES AGENCY

Applications are invited for the undernoted vacancies:

SUPPLIES DIVISION

SECTION HEAD (Ref U551)

A vacancy exists in the Division's Scientific and Technical Branch for an Officer specialising in Dental, Chiropody and Audiology Equipment.
Duties include advising on the planning and equipping of surgeries, clinics and laboratories in Dentistry, Chiropody and Audiology.
Candidates should possess sound experience in the above fields, be knowledgeable on types of equipment available, and be fully conversant with the relevant National and International Standards covering these types of equipment. Candidates should also be of degree or higher Technical Qualification Standard or alternatively have attained high professional achievement and relevant experience in lieu.
Salary Scale (PTO I Grade) £9637 rising by annual increments to £12 173 per annum.

SCOTTISH ANTIBODY PRODUCTION UNIT

HEAD OF UNIT (Ref U543)

TOP GRADE SCIENTIST

(PROTEIN PURIFICATION AND ANTI-SERUM PRODUCTION)

Applications are invited from candidates possessing the specialised experience and skills to head the Scottish Antibody Production Unit and become involved in a unique area of work in Scotland.
Applicants should have high academic qualifications combined with distinguished research background in an appropriate field. Considerable experience and e proven track record in all aspects of protein purification and anti-serum production, especially with the application of large animals, is essential. Applicants should also have extensive experience of staff management at a suitable level within a similar laboratory environment.
Salary Scale £16 090 rising by annual increments to £19 117 per annum.
Further particulars and any clarification on this post may be obtained by telephoning Dr A. E. Bell 031 556 8501 Ext 2164.
Application forms and further information on both posts are available from the Appointments Section, Common Services Agency, Trinity Park House, South Trinity Road, Edinburgh EH5 3SE to whom completed applications should be returned no later than 23 November 1983. Please quote appropriate reference number.

Textile Chemist

Printing and Dyeing Applications

Surrey **Attractive negotiable salary**

Here is an opportunity to project manage technical staff engaged in extending the applications of alginates in textile printing and dyeing. This specialist team is part of a total research and development group of 30 geared to achieving commercially viable applications within numerous industrial sectors.

Applicants must have a minimum of 5 years practical experience in textile printing technology, plus a degree level knowledge of chemistry. Technical expertise must be supplemented by the ability to guide, train and motivate a research group to attain realistically agreed objectives. The position will involve close liaison with the Marketing and Technical Sales departments, particularly as projects progress to full scale application trials. There will be overseas travel to both customers and external research establishments, where technical presentations will be made by the project manager.

Our market leader client is part of a profitable international group offering substantial R and D funding, considerable technical challenge, real career prospects and attractive financial rewards to applicants currently earning around £10,000.

Male and female candidates should apply for our confidential form quoting Ref: 588/NS.

Wickland Westcott & Partners
Management Selection/ Training & Development

Eagle Star House, 16a Alderley Road, Wilmslow, Cheshire. SK9 1QX

Telephone: (0625) 532446.

LEATHERHEAD FOOD R.A.

INFORMATION SCIENTIST MARKETS/BUSINESS OPPORTUNITIES

A new post has been created in our Information Department to handle the greatly increased demand for information on international markets and business opportunities. These relate primarily to food products and raw materials but also cover other areas as well as home and abroad.

The work will involve the gathering of published material initially, followed by the production of a computerised food market data base and, the provision of market up-dates for subscribing customers.

The ideal candidate will be a graduate with a good honours degree (2(i) or better in the case of a new graduate) with a strong bias towards business and economics. Experience in information work and the use of computers will be an advantage but more important will be the ability to respond quickly and effectively to urgent requests for information.

Salary range will be aae from £5625 on a scale rising to over £10 000 with excellent career prospects.

Please write with career details to Alastair Henry, Manager – Personnel Department, Leatherhead Food Research Association, Randalls Road, Leatherhead, Surrey KT22 7RY and quote Ref 83/23.

Closing date 18 November, 1983.

West Berkshire Health Authority
Department of Community Medicine

INFORMATION & RESEARCH OFFICER

£7404-£9025 pa

The responsibilities of this post will include assisting in the development of information systems contributing to the planning process and working with other members of the Department of Community Medicine in the study of health service problems. Applicants should be experienced in statistical and research techniques. A suitably qualified post holder will normally be granted honorary membership of the academic staff of the University of Reading in the Department of Applied Statistics and will undertake certain teaching responsibilities.

Informal enquiries welcome to Dr P. Dixon, District Medical Officer: tel Reading (0734) 875111 ext 239. Application form and job description from Appointments Unit, Great Western House, Station Road, Reading RG1 1LU: tel Reading 586161 ext 276. Closing date: 15 November, 1983.

Middlesex Polytechnic

Microelectronics Centre

Research Staff

● RESEARCH FELLOWS

(Temporary three-year appointments) £8202-£10 788 pa inc

● RESEARCH ASSISTANT

(Temporary one-year appointment) £5934-£7848 pa inc

● RESEARCH TECHNICIAN

(Temporary three-year appointment) £8751-£9309 pa inc

Opportunities to work with an active research group and teachers on various topics in the field of silicon integrated circuit design and fabrication. The Centre is fully equipped for such work, much of which is carried out in association with industry. The SERC funded technician post is for a programme of work on ion beam etching of microelectronics device structures.

Appropriate qualifications and experience in electronics, physics or certain fields of chemistry are expected.

Further information, Dr J. B. Butcher, Middlesex Polytechnic, Bounds Green Road, London N11 2NQ. Telephone 01-368 1299.

Application forms are available from Personnel Office, (ref A385D), Middlesex Polytechnic, 114 Chase Side, London N14 5PN. Telephone 01-886 6599. Closing date 14 November.

UNIVERSITY OF STRATHCLYDE

Department of Chemical and Process Engineering

LECTURESHIP

Applications are invited for a Lectureship in Biochemical Engineering in the Department of Chemical and Process Engineering. Candidates should be capable of teaching at undergraduate and postgraduate levels and of leading a research group in the biotechnology area of downstream processing.

Salary on the Lecturer Scale (£7190-£14 125 pa) USS benefit.

Further particulars and application forms (quote ref 63/83) are available from the Academic Staff Office, University of Strathclyde, McCance Building, 16 Richmond Street, Glasgow G1 1XQ.

Closing date for applications: 25 November, 1983.

Submarine Optical Cable Development

c £8K **Rural S.E. England**

Recognised os o world leader in the development of Opticol Telecommunication Systems our client hos been consistently ocknowledged for the excellence of their pioneering work in this ond mony other telecommunication reloted fields.

They ore now seeking to recruit o further engineer to join o multi-disciplinary team engoged in pioneering the use of opticol cobles in o submorine environment.

Quolified to degree level in mechonicol engineering, physics, metollurgy or materials science, with two years practicol experience, you will be involved in experimentol ond development work on both cobles ond repeaters ond lioison with the U.K. monufocturing units.

In addition to the solory the post offers o full range of fringe benefits ond excellent career prospects in o research environment that offers some of the best focilities in the U.K.

Please write with C.V. or telephone for on opplication form, quoting ref 124/A, to:
Larkfield Recruitment Advertising, Mill Reef House, 9-14 Cheap Street, Newbury, Berks. RG14 5DD. Telephone: (0635) 48709.

LRA Larkfield Advertising

THE HANNAH RESEARCH INSTITUTE

ANIMAL SCIENTIST

Applications are invited for a post in the Department of Animal Nutrition and Production to undertake work on forage utilisation and milk production in the dairy cow.

Applicants should possess a first or upper second class honours degree in Nutrition or a related subject and should have at least two years post-graduate experience in animal production research. Preference will be given to candidates with experience of work on forage utilisation or on milk production in the dairy cow.

Appointment will be to the Higher Scientific Officer grade, salary scale £7149 to £9561. A non-contributory superannuation scheme is in operation.

Further particulars may be obtained from: The Secretary, The Hannah Research Institute, Ayr KA6 5HL in whom applications including curriculum vitae and the names and addresses of two referees should be forwarded by 25 November, 1983 quoting reference HRI/73.

THE UNIVERSITY OF MANCHESTER

Department of Biochemistry

POST-DOCTORAL RESEARCH ASSOCIATE

Applications are invited for the above post to commence research into alterations in the connective tissue matrix of human aorta which may predispose towards dissecting aneurysms. The project is in collaboration with Dr P. S. Hasleton of the Pathology Department, Regional Cardiothoracic Centre, and is supported by a grant from the British Heart Foundation. Applicants should be 27 years old or less, and should be experienced in connective tissue biochemistry. The post is tenable for three years, to commence as soon as possible at a starting salary of up to £8530 pa (with Superannuation). Applications in duplicate with full cv including names of two referees should be sent to Dr J. C. Anderson, Department of Biochemistry, Medical School, University of Manchester, Oxford Road, Manchester M13 9PT as soon as possible.

Laser Scientist

Laser Applications to Microcircuit Fabrication

The Laser Development group of the Laser Division at the Rutherford Appleton Laboratory has a vacancy for a Research Associate at the postdoctoral level, or equivalent, to work on the applications of ultraviolet excimer laser sources to microcircuit fabrication.

The successful applicant will work on a major new project to investigate the use of UV lasers to photolithography and microcircuit fabrication. The high powers in the ultraviolet available from excimer lasers offer the possibility of greater resolution and throughput relative to that achievable by current silicon chip production techniques. A substantial part of this programme will be a study of the use of phase conjugate mirrors to produce diffraction free images and to project them without the need for high quality lenses. There will be ample opportunity for the candidate to perform innovative basic research in these areas.

The project, which is jointly funded by the Department of Trade and Industry and the SERC, will involve a close collaboration with groups at Oxford University and the Electron Beam Lithography group of the Technology Division at RAL. Industrial collaboration during the latter stages of the project is also envisaged.

Applicants should have a PhD degree, or equivalent, and experience in such fields as laser physics, linear or non-linear optics, or photolithography.

The period of appointment is for three years and in the salary range of £6,985 to £10,686 per annum.

The Laboratory is a friendly community with its own restaurant and sports facilities nearby. Benefits include a local transport service and generous leave allowances.

Application forms are available from: Recruitment Office, Rutherford Appleton Laboratory, Science and Engineering Research Council, Chilton, Didcot, Oxon, OX11 0QX. Tel: Abingdon (0235) 445435 quoting ref. no. VN184.

Closing date: 16th December 1983

serc Rutherford Appleton Laboratory

OXFORD POLYTECHNIC DEPARTMENT OF BIOLOGY

Postgraduate Research Training

A vacancy exists for a Researcher A post (£4947 pa) from 1 January, 1984, in one of the following areas:
1 The historical ecology of Bernwood Forest, Buckinghamshire (with Dr D. F. Owen).
2 Feedback control mechanisms on ion absorption and transport in higher plants (with Dr I. P. Cumbus).

The successful applicant will be expected to register for a higher degree (MPhil/PhD), as well as undertaking 200 hours teaching per year on undergraduate biology courses.

Details of research in the Department may be obtained from the Postgraduate tutor.

Applicants should possess a good honours degree in an appropriate subject and should provide a curriculum vitae and the names of two referees. Applications should state the project of interest and be sent as soon as possible to:
The Postgraduate Tutor, Department of Biology, Oxford Polytechnic, Headington, Oxford OX3 0BP.

Reference B10 10 (RA).

SEVERN TRENT WATER AUTHORITY

FISHERIES BIOLOGIST

£8154—£9033 pa

Based at Nottingham, the successful applicant will be a member of a small team providing a specialist Fisheries Biological Service for the Trent Basin. Duties will be wide ranging and include fish population monitoring; advice on fish rearing and some research studies.

Candidates must possess a good honours degree in zoology (or equivalent) and have at least three years post graduate experience in an aspect of freshwater fisheries biology which is relevant to the Authority's fisheries conservation duties. Research experience: corporate membership of the Institute of Fisheries Management and current employment within the water industry would be added advantages.

Application forms, quoting reference SF17, and further details are available from the Regional Personnel Manager, Severn Trent Water Authority, 2297 Coventry Road, Sheldon, Birmingham B26 3PU. Telephone 021-743 4222. Extension 2076/2077.

Closing date for the return of completed application forms: 17 November, 1983

SEVERN TRENT WATER

ANAESTHETIST
ANIMAL NUTRITIONIST
HOSPITAL TECHNICIAN
INSTRUMENT TECHNICIAN
OPHTHALMOLOGIST
PATHOLOGIST
POTATO SCIENTIST
TELECOMS ENGINEERS
VETERINARY SPECIALISTS

These are some of the two-year posts in developing countries which United Nations Volunteers is now trying to fill. Your practical skills and experience could help bridge the gap between rich and poor countries.

Each developing country wants to use your skills to build up self-reliance. The work demands commitment and sensitivity; the willingness to learn as well as give.

You must have over two years' post qualification work experience and be willing to spend two years overseas on volunteer terms.

For further details and an application form, send coupon below to Enquiries Unit, VSO-UNV Scheme, 9 Belgrave Square, London SW1X 8 PW.

UNV

Name .....

Address .....

.....

Quals/Experience .....

(UNV/1)

The Medicine Group

STAFF EDITORS

We publish international clinical journals for doctors and nurses, and an increasing number of occasional publications and conference proceedings. The various editions of MEDICINE International now have a worldwide circulation of over 250 000 copies per month.

Owing to recent internal promotions, we are looking for two staff editors to join the editorial team working on medical journals. Our staff editors progress manuscripts into well-edited and well-illustrated articles, which involves liaison with the authors and with our own production and design departments. We work to tight deadlines, and staff editors must be able to work to high standards of accuracy, and to use their own initiative.

A science degree is essential, and previous experience in publishing would be an advantage.

Salary range is £5010—£6690 (under review January 1984).

Please send a brief curriculum vitae in your own handwriting, including details of your education, employment and interests to:

ALISON HILLMAN
Managing Editor,
The MEDICINE Group
Pembroke House
36/37 Pembroke Sreet, Oxford OX1 1BL

LOTHIAN HEALTH BOARD

AUDIOLOGICAL SCIENTIST

This is a new principal grade post which has been established as part of the development of an area wide Lothian Health Board Audiological Service, with a special interest in the treatment of the adult deaf, within a larger established ENT Service. A wide range of services are currently provided by medical and PMT staff but it is envisaged that an Audiological Scientist will bring a special expertise to the further development of audiological services.

A 1st class or 2nd A class honours degree in a relevant subject together with at least five years postgraduate experience in audiological techniques in a clinical situation would be essential together with either the Diploma or MSc in Audiology.

PTA and General Whitley Council conditions of service apply. Salary scale £11 413 to £16 010 per annum.

A job description and further information is available from the Personnel Officer, Lothian Health Board, 11 Drumsheugh Gardens, Edinburgh EH3 7QQ to whom completed applications, which should be typewritten and include the names and addresses of two referees should be sent not later than four weeks from the date of this advertisement. Please quote M/055.

Kineticist

Salary Range £10,000 - £14,000

B.P.'s Research Centre at Sunbury is extensively involved in the study of hydrocarbon and other chemical reactions, ranging from fundamental research to the development and commercialisation of new processes.

As part of this overall activity, New Process Development Branch requires an experienced Kineticist to lead a small team involved in kinetic and mechanistic studies. The main current emphasis is on heterogeneous catalysed hydrocarbon reactions, but the successful candidate is expected to apply kinetics expertise across a wide range of topic areas.

Candidates should have a good degree in chemistry, a PhD in a relevant field (e.g. heterogeneous catalysis, surface or gas-phase kinetics) and a minimum of five years' post-doctoral experience in relevant academic or industrial research. Capability in both experimental and theoretical work is sought.

Starting salary within the range £10,000 - £14,000 will be dependent on ability and experience. An attractive benefits package includes a non-contributory pension scheme, subsidised restaurant, on-site sports and social facilities and relocation assistance, where appropriate.

Please write in full, quoting ref. SR 5317 to: Anne Hendry, The British Petroleum Company plc, BP Research Centre, Chertsey Road, Sunbury-on-Thames, Middlesex TW16 7LN.

BP Research
SUNBURY-ON-THAMES

KINGSTON POLYTECHNIC

Research in Polymers
School of Chemical and Physical Sciences

Applications are invited from Honours graduates in chemistry, materials science or related disciplines, for a research assistantship to study the effects of moisture on the properties of epoxy resins reinforced with carbon. A suitably qualified appointee would be allowed to register for a higher degree, under the direction of Dr G. Pritchard.

Salary range £5592-£6294 (including £645 London allowance).

Details and application forms, to be returned as soon as possible, from Academic Registry, Dept. AO, Kingston Polytechnic, Penrhyn Road, Kingston upon Thames KT1 2EE.
Tel: 01-549 1366.

POLYTECHNIC OF CENTRAL LONDON

GRADE 6 TECHNICIAN—

Environmental Design Laboratory Technician

This post is concerned with the operation of laboratory areas supporting studies in environmental design and science.

Applications should be well qualified and experienced in the use and maintenance of scientific equipment, have some appreciation of environmental design, and the personal qualities required for working with students.

Salary on scale £8423-£9824 pa inclusive of London Allowance. Application form and further details can be obtained from the Establishment Office, PCL, 309 Regent Street, London W1R 8AL.

Closing date: 18 November, 1983.

Graduate Toxicologist

As a result of an impending expansion and transfer to a new site near Chelmsford, Essex, our Toxicology Department requires an additional Toxicologist to join the General Toxicology Unit.

Applicants should have a good Honours Degree, preferably in Pharmacology or Physiology, and a minimum of two years experience in the design, conduct and reporting of general toxicology studies to internationally accepted standards.

Please contact The Personnel Officer, Beecham Pharmaceuticals Research Division, Honeypot Lane, Stock, Essex CM4 9PE, for an application form, quoting ref. no. 4/83.

Beecham
Pharmaceuticals

Royal Postgraduate Medical School

(University of London)

Technician/ Research Assistant

required immediately for the Catecholamine Group of the Department of Clinical Pharmacology

This post is part of an active research group investigating mechanisms of hypertension, and the role of presynaptic adrenoceptors in both animals and man. The successful applicant will assist with radio-enzymatic catecholamine assays, and with intracellular calcium measurements by the new QUIN ester technique. The post is ideally suitable for sandwich course graduates or equivalent with one year's experience, but recent university graduates wishing to acquire laboratory experience would also be considered.

Further particulars and application forms are available from the **Personnel Office, Royal Postgraduate Medical School, 150 Ducane Road, London W12 0HS.** The salary is £5864-£7323 depending on experience.

Please quote reference 20/207/NS.

Closing date: 17 November, 1983.

UNIVERSITY OF LONDON

Institute of Neurology

POSTDOCTORAL RESEARCH ASSOCIATE
(Long-term appointment)

Required to work in the Department of Neurochemistry for a group identifying vulnerable neurones in degenerative cognitive disorders, with the aim of unearthing potentially reversible changes which might be drug responsive. Broad experience is required, for work which could involve neurone isolation and identification, including immunocytochemistry, neurotrophic factors and *in vivo* study of transmitters, particularly excitatory amino acids and high performance liquid chromatography.

The appointed person may be made an Honorary Lecturer and would be encouraged to consolidate research links with the National Hospital for Nervous Diseases and clinical academic centres in two other cities.

The salary will be on the lecturer scale according to age and qualifications. Applications, CV and name of two referees should be sent by 14 December, 1983 to The Secretary, Institute of Neurology, 23 Queen Square, London WC1N 3BG.

Southampton THE UNIVERSITY

Institute of Sound and Vibration Research

Research Assistant required to work on Vibration isolation, initially for two years, at the Institute of Sound and Vibration Research, University of Southampton. A first degree in Mathematics, Physics or Mechanical Engineering would be desirable. Salary range 1B, £6310-£8530 per annum. Applications in duplicate, including the names of two referees, should be sent to **Mr D. A. S. Copland, Staffing Department, University of Southampton, Highfield, Southampton,** quoting ref. 2041/R.

BSRA

Technology Transfer for the 80's

PRINTING: PUBLICATIONS: COMPUTER BASED SYSTEMS

NORTH EAST

The British Ship Research Association (BSRA) is one of the leading Research Development and Consultancy organisations for the British Marine industries. We work on a joint programme of R&D projects with British Shipbuilders, our main customer. However, we are doing an increasing amount of work on a commercial basis for shipowners, shipbuilders, the Government etc. both within the UK and abroad. There are 250 members of staff at our Tyneside site.

We are seeking a manager to head up our Document Publication and Technical Information areas whose role will be to establish and achieve profit targets and service levels for those areas. This will be done by identifying the activities of the areas that can be commercially exploited and ensuring that exploitation takes place. At the same time the job holder will have to ensure that the existing roles are carried out in the most effective way, having regard to technical developments.

In order to do this job you are likely to be a graduate or have an HND and have experience within the printing/publishing industry including customer liaison or sales experience. You must demonstrate a proven track record in man management (you will have 25 people to manage). A knowledge of PR methods would be useful and up to date knowledge of the technology in the communications field is essential.

We will pay you the competitive package of salary and benefit you would expect from a progressive employer.

If you would like an application form please phone or write to:

Miss Cathy Fish,
THE BRITISH SHIP RESEARCH ASSOCIATION,
Wallsend Research Station, Wallsend,
Tyne & Wear NE28 6UY
Telephone 0632 625242

Please quote the reference 83/27

Graduates & Technicians

for Metabolism & Pharmacokinetics

We are Europe's largest research unit operating in the Life Sciences area. As a result of our continuing development and expansion there are vacancies for graduates and technicians in our Department of Metabolism and Pharmacokinetics.

Candidates should possess or be studying for an appropriate qualification (HNC AIMLS, MIBiol, GRSC, BSc). The work will involve studies of the metabolic fate and pharmacokinetics of drugs, pesticides and food additives using radioisotopes and other analytical techniques (e.g. GC, HPLC, etc). Relevant experience would be desirable but proven practical ability is of prime importance.

These vacancies provide an ideal opportunity for suitably qualified scientific staff to join one of the leading drug metabolism research groups in the UK. Attractive career opportunities based on merit exist.

The Centre is located near Huntingdon in an attractive part of the country with good access to London by road and rail. We offer excellent working conditions together with progressive general benefits, a competitive salary and the usual pension and other fringe benefits.

Please apply with full C.V. to Nancy McCree, Personnel Officer,
HRC Huntingdon Research Centre plc, Huntingdon. PE18 6ES.
Telephone Huntingdon 890431.

Huntingdon Research Centre plc

Southampton THE UNIVERSITY

Sub-Department of Engineering Materials

Applications are invited for the post of Lecturer in the Sub-Department of Engineering Materials. Candidates should have a background in Metallurgical or Production Engineering, Engineering Materials or a related subject and a research interest in deformation processing of materials.

Salary scale: £7190 x £450 (approx) to £14 125 per annum. The initial salary will depend on qualifications and experience.

Further particulars may be obtained from **D. A. S. Copland, The University, Southampton SO9 5NH,** to whom applications (seven copies from United Kingdom applicants) should be sent not later than 30 November, 1983, quoting reference No. 2040.

MRC Medical Research Council

Toxicology Unit

Technician

is required to assist in biochemical investigations into the mechanisms of metabolic activation of acetylenic substituted compounds. Such work includes the isolation and identification of active metabolites following their reaction with cellular macromolecules.

Qualifications: HNC, Degree or equivalent. Salary according to age, qualifications and experience within range £5491-£7747 + £596 London Weighting.

Apply in writing, with curriculum vitae and the names of two referees to: Dr I. White, MRC Toxicology Unit, Woodmansterne Road, Carshalton, Surrey SM5 4EF.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY
RESEARCH ASSISTANT

required to join small group investigating aspects of gaseous sterilisation. Good class degree in microbiology or microbiology/biochemistry essential. Appointment to 30 September, 1985. Salary in range £6310-£6745 + £1186 London Allowance.
Applications with names of two referees to Dr A. H. Dadd, Department of Pure and Applied Biology, Imperial College, London SW7 2BB.

ETON COLLEGE
SENIOR LABORATORY TECHNICIAN

required in the Physics Department from January. The successful applicant would be expected to play a large part in reorganising the technical side of the Dept when it moves into new accommodation in Sept 1984, so experience in a school, university or industry would be an advantage.
Further details and application form from the Head of Physics, Eton College, Windsor, Berks SL4 6EW.

MRC RADIOBIOLOGY UNIT, HARWELL

RESEARCH OFFICER

A vacancy exists for a Research Officer on the staff of this Medical Research Council Unit, for an initial period of three years. The post-holder will be seconded to the *INSTITUTE OF CANCER RESEARCH AT SUTTON*, in Surrey, to work within the Radiotherapy Research Laboratories.

The successful candidate will work with an MRC Clinical Scientist using HPLC assay of new chemical radiosensitizing drugs in clinical specimens, and will also study the radiobiology and cell biology of human tumour cells, both in animal models and *in vitro*.

Qualifications required are a degree or HTEC/HNC in a relevant subject. Unless the successful candidate has at least two years relevant laboratory experience they will be appointed as a Technician.

Salary according to age and experience on the scale £6204-£6126 for a Research Officer and £5491-£7747 for a Technician.

If you would like further information, please contact: Dr A. Horwich, The Royal Marsden Hospital, Downs Road, Sutton, Surrey SM2 5PT. Telephone number 01-642-6011.

All applications, together with the names of two referees, should be sent to the Personnel Officer, MRC Radiobiology Unit, Harwell, Didcot, Oxon OX11 0RD. Ref: AH/NP. Closing date 28 November.

Experimental Officer/Analyst

We are seeking a person with HPLC experience who will develop methods for the quantitive anelysis end characterisation of new pesticides es their technical and formulated materiels. These methods will be used both within end outside the Company. We would like e lively personelity both to establish close contect with our orgenic chemists and to assist in the development of HPLC as e technique. There will also be opportunity to become involved with the wide aspects of laboratory computerisation. Candidates ehould heve e degree or equivalent in Chemistry.

Jeelott's Hill Research Station is loceted in pleasant surroundings between Brecknell and Maidenhead. Salery £7000 pa—£8000 pe plus membership of the ICI Profit Sharing Scheme and Pension Fund. There is a steff restaurant, recreation club end shop on site.

Candidates should epply to the address below, giving e cv covering details of their cereer to date with ell relevant experience. They should elso indicate why they are perticularly intereeted in this job and any other speciel skills which might aid its development.

Personnel Department
ICI Plent Protection Division
Jealott's Hill Research Stetion
Bracknell
Berkshire
Please quote reference number 83/MJT

ICI Plant Protection Division

UNIVERSITY OF BRISTOL

Department of Mechanical Engineering

CAD/CAM Lectureship

Applications are invited for a Lectureship within the Department of Mechanical Engineering to work in the areas of Computer-aided Design and Computer-aided Manufacture, including Manufacturing Systems

The post has been created to enable the Mechanical Department to extend its activities in Design and Manufacture in collaboration with the Electronic Department and Industry. A group formed from staff within the two Departments is already actively engaged in Robotics. However, the successful candidate would be expected to liaise also with other staff working in associated areas within the Faculty

Applicants with relevant experience in industry and/or research are sought. The commencing salary will be at an appropriate point, according to age, qualifications and experience on the scale £7190-£14 125 per annum

Further details may be obtained from The Registrar and Secretary, University of Bristol, Senate House, Bristol BS8 1TH, to whom applications, together with a curriculum vitae and the names and addresses of three referees should be sent by 30 November, 1983. Please quote reference JPB

UNIVERSITY OF NEWCASTLE UPON TYNE

Department of Agricultural Biochemistry & Nutrition

RESEARCH ASSOCIATE

A Research Associate is required for an ARC-funded programme of research to study the exogenous supply of glucose, arising by digestion of starch in the small intestine of pregnant and lactating ruminants. Candidates should have a good Honours degree in Biochemistry, Physiology, Animal Nutrition or an appropriate biological discipline; they should also have had considerable postgraduate experience and preferably have a PhD degree.

The appointment is for three years with initial salary up to £8530 pa on the Range 1A scale (£7190-£11 615) according to age, qualifications and experience.

Applications, with the names and addresses of three referees, should be sent to Professor D. G. Armstrong, Department of Agricultural Biochemistry and Nutrition, The University, Newcastle upon Tyne NE1 7RU by 11 November, 1983.

INNER LONDON EDUCATION AUTHORITY

South London College, Knights Hill, London SE27 0TX.
Tel No 01-670 4488.

GEOLOGY TECHNICIAN GRADE 6

Required to organise the day to day running of technician services in the Geology Section. The main work of the section is for the TEC Higher Diploma/Certificate courses in Geological Technology/Oil Exploration. There is also some GCE 'A' level work.

Applicants should have HNC, HND, Advanced City and Guilds or equivalent qualifications plus a minimum of nine years experience (including training period).

Salary scale: £7203 to £8640 plus £500 London Weighting.

Application forms are available from the Deputy Administrative Officer at the College and should be returned to EO/Estab 3a, Room 255a, County Hall, London SE1 7PB within 14 days of the appearance of this advertisement.

ILEA is an equal opportunity employer.

STRANGEWAYS RESEARCH LABORATORY

RESEARCH OFFICER

Applications are invited for the post of Research Officer, funded by the British Heart Foundation, within a group headed by Dr M. J. Barnes, studying mechanisms underlying vascular disease. The person appointed will undertake investigations to define the role of Factor VIII/von Willebrand factor in the activation of blood platelets by collagens in haemostasis and thrombosis.

The post is for three years with a maximum starting salary, based on MRC research officer scales, of £6204 pa. Applicants should have a suitable science degree and preferably one or two years appropriate research experience. The successful applicant will have the opportunity to register for a higher degree.

Applications, including curriculum vitae and the names of two referees, should be made before 25 November to the Administrative Secretary, Strangeways Research Laboratory, Worts Causeway, Cambridge CB1 4RN.

Sales Person

Biotechnology Instrumentation

We require a young graduate/technically qualified person to assume responsibility for marketing a range of electrophoresis and associated products.

This will be a challenging and rewarding position within a rapidly expanding company. Person will be based in the Oxford, Cambridge, London area

Further details contact: **P. M. Nicklin, Genetic Research Instrumentation, Gene House, Takeley, Bishop's Stortford, Herts. Tel: 0279 870601.**

Ministry of Defence

Computer Specialists

There are currently the following opportunities:

Royal Naval Engineering College, Manadon, Plymouth

Applications Programmer

... to be responsible for application programming tasks, providing detailed advice to staff and students, supporting and developing graphics facilities.

Candidates should have a degree in Computer Science or related subject and experience or interests in the above areas.

Appointment as Scientific Officer.

Royal Military College of Science, Shrivenham, Swindon, Wilts.

Programmer

... to undertake a wide range of programming activities, mainly application programs but also assisting in the development of systems software.

Candidates should have an honours degree with a strong computing context and at least two years postgraduate experience. A minimum of one year's practical programming experience and familiarity with at least two of BASIC, PASCAL, FORTRAN or CORAL 66 is desirable.

Appointment as Higher Scientific Officer

Salaries: Higher Scientific Officer £7145-£9560, Scientific Officer £5680-£7765. Starting salary according to qualifications and experience.

For further details and an application form (to be returned by 25 November 1983) write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours).

Please quote ref: SY/15/D.

Scientific Civil Service

Cell Biology Technician

Greenford, Middlesex

is required to join a small group investigating the mode of action and chemotherapeutic potential of anticancer drugs. Studies involve the establishment, growth and biological characterisation of tumour cell lines using a variety of cell biology techniques. The evaluation of selected anticancer drugs in these tumour cell lines requires a careful, methodical approach, involving the application of some biochemical methodology.

The successful candidate will have HNC or equivalent in an appropriate subject and will enjoy using his or her own initiative, whilst nonetheless being able to work in close contact with other members of the team. Experience of biochemical techniques, cell culture and microscopy would be useful but is not essential.

The company offers excellent conditions of employment including non-contributory pension scheme, bonus schemes, subsidised canteen and an active Sports and Social Club.

Please send a CV or telephone for an application form to: The Personnel Officer (REN), Glaxo Group Research Limited, Greenford Road, Greenford, Middlesex UB6 0HE. Tel: 01-422 3434 extension 2573 quoting reference number 507.

Glaxo *Group Research Ltd.*

DURHAM UNIVERSITY

Department of Mathematical Sciences

Applications are invited for the post of

POSTDOCTORAL SENIOR RESEARCH ASSISTANT

in Elementary Particle Theory tenable for two years from 1 October, 1984 under the direction of Drs E. F. Corrigan and D. B. Fairlie for investigations in the Structure of Gauge Theories. There is scope for working on a variety of different topics.

Initial salary in the range £7190-£8530 pa plus superannuation.

Applications (three copies) naming three referees should be sent by 9 December, 1983 to the Registrar, Science Laboratories, South Road, Durham DH1 3LE, from whom further particulars may be obtained.

CHARING CROSS HOSPITAL MEDICAL SCHOOL
(University of London)
Department of Medical Oncology

TECHNICIAN

with interests in Biochemistry/Chemistry required to join multidisciplinary team designing and evaluating conjugates of antibodies with cytotoxic agents for anticancer therapy. The post will be funded by the Cancer Research Campaign according to the Whitley Council MLSO salary scale.

Applications on forms obtainable from The Secretary, Charing Cross Hospital Medical School, The Reynolds Building, St Dunstan's Road, London W8 8RP, (Tel: 01-748 2040 Ext 2067) to be submitted within three weeks of the appearance of this advertisement.

Food Analyst

A small research team working within the Mars Group of companies requires a Food Analyst.

The post, based at Basingstoke, will involve setting up a laboratory and implementing quality assurance procedures for raw materials, intermediates and products. In addition, creativity and ingenuity will be required to support the research and production programme.

The successful applicant (male or female) will be qualified to a minimum of HNC in a relevant subject and will have at least 2 years' analytical experience involving both classical and instrumental techniques in the food or biochemical field, with specific recent experience in amino acid analysis and gas chromatography. A clean driving licence is also essential.

The position will be on an initial contract of up to one year on a weekly salary of £200, starting early December.

For an application form and early interview, telephone Laurie Haywood on Basingstoke (0256) 54119.

LEWISHAM AND NORTH SOUTHWARK HEALTH AUTHORITY

Poisons Unit

New Cross Hospital, Avonly Road, London SE14 5ER

A vacancy exists for a

JUNIOR MEDICAL LABORATORY SCIENTIFIC OFFICER

to work in the Poisons Unit, New Cross Hospital, which provides a toxicological assay service to hospitals.

Salary Scale: £3456-£4816 pa plus London Weighting. Commencing salary scale depends on age and qualifications. Minimum qualifications are two "A" levels or their equivalent which should be in chemistry and one other science subject.

An application form may be obtained from the Personnel Officer, Guy's Hospital, Tel 01-407 7600 Ext 3445.

Please quote Ref: U/186.

BRITISH MUSEUM

ASSISTANT SCIENTIFIC OFFICER

Duties include assisting with experimental work for research projects, routine analyses and testing of materials.

Candidates should possess GCE "O" level passes or grades A, B or C (or equivalent) in four subjects including English Language and Chemistry.

Salary £4215 pa at 16 to £5535 pa at 20; £5797 pa at 21 or over.

Apply on a postcard to Establishment I (ref 48/83) British Museum, Great Russell Street WC1B 3DG.

Closing date for completed application forms 25 November, 1983.

R & D Project Planner

£8550—£12 350 Berkhamsted, Herts

The efficient organisation of our project work within the Group R & D Directorate plays a critical role in meeting our business development plens. To strengthen our team in this aree we now have an opportunity for e project planner to assist in the implementation end planning of a wide veriety of medicel, veterinery end entomologicel projects et our locations close to the London area.

Primarily besed at our Research Laboratories et Berkhamsted, Herts, end reporting to the Senior Project Planner (Beckenham, Kent) the successful candidete will be involved in the applicetion of network planning procedures, the compilation of plenning charts and the analysis of data by computer. There will be e close liaison with project leaders end line menegers involved in the development of potential new products end en opportunity to perticipate in the development of improved methods of planning and the evaluation and monitoring of R & D projects.

Cendidetes must heve e degree or equivelent qualificetion, good communication skills end the ability to interact effectively et ell levels within a professional multi-disciplinary environment. Experience in the pharmaceuticel industry, femiliarity with R & D, a positive interest in planning techniques and an administretive cereer ere, of course, essentiel requirements.

Excellent benefits include 5 weeks' holiday, life assurence and pension schemes, subsidised resteurent, first class sports and social fecilities end generous essistence with relocation expenses where appropriate.

For an application form please telephone 01-650 6541 (24 hour ansaphone) quoting reference number: 248. Alternatively, pleese write to P. Anderson, Personnel Officer, The Wellcome Research Laboretories, Langley Court, Beckenham, Kent BR3 3BS.

Closing dete of epplications 17th November.

Wellcome

BRITISH MUSEUM (NATURAL HISTORY) SOUTH KENSINGTON, LONDON, SW7

require an

ASSISTANT SCIENTIFIC OFFICER

to join a small team providing an electron microscopy service for taxonomic research covering the whole field of natural science. Duties include preparing material for both scanning and transmission microscopy, supervising microscope users, some involvement in research programmes, first line maintenance of microscopes and vacuum units.

Qualifications, 4 passes in GCE 'O' level, or equivalent, including English language and a scientific or mathematical subject. Training will be given but knowledge and experience of electron microscopy would be an advantage.

Salary £4215 pa (age 15) to £5535 pa (age 20), age 21 and over £5797 pa rising by annual increments to £7264 pa (inclusive of Inner London Weighting).

5 day, 41 hour week.

for application form contact:

Miss A. Cargill
Establishment Section
British Museum (Natural History)
Cromwell Road
London SW7 5BD

Telephone, 01 589-6323 ext 273

Closing date for completed application form 17 November 1983

THE UNIVERSITY OF MANCHESTER

CHAIR IN MICROELECTRONICS

As part of its response to the Alvey initiative the University has established a Chair in Microelectronics to strengthen its commitment to information technology. Applications are invited for the Chair from candidates with an academic and/or industrial background. Applications (suitable for photo-copying) giving full details of qualifications, experience, research etc, and the names and addresses of three persons to whom reference may be made should be sent by 30 November, 1983 to the Registrar, The University, Manchester M13 9PL (from whom further particulars of the appointment may be obtained). Please quote ref 177/83/NS.

STATISTICIAN/ENGINEER

for water flow prediction

INSTITUTE OF HYDROLOGY, Wallingford

The Applied Hydrology Division of the Institute of Hydrology requires a graduate civil engineer or applied statistician for work in the flood and low prediction section. Current projects include a European Flood Study, an investigation into the flood statistics of pumped fen catchments and a study of residual flows from reservoirs. Duties of the post include archiving flood and catchment information; the development of procedures for calculating catchment characteristics from digitised thematic maps; using statistical and contouring packages to develop relationships between flood statistics and catchment characteristics. The post will also involve assisting with training courses and ad hoc repayment work as well as with responses to enquiries from Flood Study Report users.

The appointment will be to the Scientific Officer (SO) or Higher Scientific Officer (HSO) grade, with a salary depending on age and experience in the range £5682-£7765 per annum (SO); or £7149-£9561 per annum (HSO).

Applicants should have a good Honours degree in the appropriate subjects for appointment to SO and at least two years' relevant post-graduate experience for appointment to HSO. Candidates with a higher degree or practical experience in hydrology, including extensive computing experience, will be preferred.

NERC is not a Government department, but conditions of service are similar to those of the Civil Service.

Further information can be obtained from Mr J. Parker, Institute of Hydrology, Maclean Building, Crowmarsh Gifford, Wallingford, Oxon. Telephone: Wallingford (0491) 38800.

Closing date for the return of completed application forms is 18 November, 1983.

NATURAL ENVIRONMENT RESEARCH COUNCIL

MANDER PORTMAN WOODWARD

The college has a small number of vacancies for

PART-TIME TUTORS

in Physics, Maths and Computer Science.

Applicants must possess a relevant degree and be familiar with the London Board 'A' level syllabus.

Please write with CV to:

The Principal, 24 Elvaston Place, London SW7

MEDICAL REPS

Have you a Science Degree, laboratory experience of 'A' levels in Sciences? If you would like a career with a future, plus excellent salary, car and other incentives, please telephone 01-530 6399. We have vacancies throughout the UK. Local interviews arranged.

Bishopsgate Employment Agency Ltd, 4 Station Approach, Snaresbrook, London E11.

UNIVERSITY OF BRADFORD

RESEARCH FELLOW/ POSTDOCTORAL RESEARCH ASSISTANT

(fixed-term appointment)

HYDRATION AND DRUG ABSORPTION IN HUMAN SKIN

Applications are invited for the above post to assist in a research programme on the hydration of human skin and its effects on the absorption of drugs, supported by Pharmacia AB (Sweden). Candidates should possess a PhD in a relevant discipline (eg Pharmacy, Chemistry, Biochemistry or Biology) and preferably have experience in applying physiochemical theory and techniques to human or animal tissue. Exceptional candidates without a PhD will also be considered. Excellent facilities available at the University and Pharmacia AB (Sweden) and the position (available immediately) is initially for one year. Starting salary in the range £7190-£8530 (Postdoctoral Fellow) or £6310-£7630 (Research Assistant). Applications with curriculum vitae and the names and addresses of two referees should be sent to the Personnel Secretary (Ref PT/RF/NS), University of Bradford, Bradford, West Yorkshire BD7 1DP. Informal enquiries to Professor B. W. Barry (Tel 0274 733466 Ext 575). Closing date asap.

UNIVERSITY OF SOUTHAMPTON

LABORATORY TECHNICIAN

Applications are invited for the post of research technician (part-time or full time) in the Human Morphology Group of the Medical School.

Applicants should be experienced in electron microscopy and/or tissue culture. Experience in a range of photographic techniques would be an advantage. Minimum qualification ON/TEC Certificate or equivalent.

The appointment will be made on grade three salary scale £5151-£6035 pa (266·9 to 312·81 p per hour part time).

Applications (two copies) giving date of birth, details of qualifications and experience together with the names and addresses of two referees should be sent to Mr C. N. Saull, The University, Southampton SO9 5NH quoting reference No 525/T.

For further details contact Human Morphology on Tel No 0703 559122 Ext 8231.

EXPERIENCED TECHNICIAN

MRC Dunn Nutrition Unit, Cambridge

We will shortly have a vacancy for an experienced technician with a special interest in the application of biochemical and physiological techniques to the solution of nutritional problems. Expertise with gas liquid chromatography an advantage.

Qualifications required: Relevant HNC or equivalent.

Salary: On the scale £5491-£7747.

Applications, including the names of two referees and full cv to:

Administrator, MRC Dunn Nutrition Unit, Milton Road, Cambridge CB4 1XJ.
Ref: GN/3.

TECHNICIAN (GRADE 3) in Dept of Microbiology, University of Reading, London Road, for classwork and to assist groups engaged in research. Previous experience in Microbiology essential. Salary in scale £5151-£6035 pa. Further details and application form available from Personnel Office, Whiteknights House, University of Reading, Whiteknights, Reading, Berks RG6 2AH. Tel 875123 Ext 448. Please quote Ref T22A.

Chemical Engineers and Metallurgists

Challenging opportunities

The Atomic Weapons Research Establishment at Aldermaston, Reading, is engaged on a significant development programme as well as a scheme to enhance its facilities. This multi-disciplinary environment requires close collaboration between engineers and scientists.

Current opportunities are for chemical engineers and metallurgists to work in the project management, design, maintenance, inspection, quality assurance, testing and safety fields. There are also a limited number of vacancies for health physicists.

Candidates must have a degree in a relevant subject or corporate membership of an appropriate professional institution or an equivalent or higher acceptable qualification. They should also have at least two years relevant professional experience.

Salaries range from £7175-£9680 according to qualifications and experience.

Rented housing may be available for married recruits presently living beyond feasible daily travelling distance.

RELOCATION ASSISTANCE MAY BE AVAILABLE.

For further details and an application form write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours).
Please quote ref: T(AL)85/S.

Ministry of Defence

SENIOR DEVELOPMENT PHARMACIST/CHEMIST

Riker Laboratories, the pharmaceutical division of the 3M Company, is part of a highly successful international organisation manufacturing a wide range of ethical and proprietary pharmaceutical products.

Due to an internal promotion, an exciting vacancy has arisen for a Section Head to manage the Solid Dosage Form Section within our Pharmaceutical Development Department. The section is comprised of seven people whose prime responsibility is the development of oral tablet and capsule formulations from initial conception through to full scale production. A secondary role is the provision of technical support to production personnel when required. The department is located in modern, fully air conditioned laboratories opened only four years ago.

This post is ideally suited for a graduate or Ph.D. pharmacist/chemist with five or six years relevant experience who is ready to accept the wider management responsibilities of a Section Head.

In addition to competitive salaries, we offer a range of benefits including Pension/Life Assurance scheme and a generous relocation package if required. Loughborough is situated in a pleasant and accessible part of the East Midlands where housing is inexpensive and readily available.

Write for an application form to Mrs E. M. Winter, Personnel Officer, Riker Laboratories, Morley Street, Loughborough, Leicestershire or for further information ring Dr B.C. Meakin on Loughborough 268181 Ext. 552.

Riker Laboratories
LOUGHBOROUGH LEICS.

3M

THE UNIVERSITY OF LANCASTER

Department of Biological Sciences

Temporary Lecturer in Genetics

Applications are invited for the above post of limited tenure for the period 1 January 1984 to 30 June 1985. Preference will be given to candidates who have completed a PhD. The successful candidate will be expected to teach within an existing basic second year genetics course and to offer specialised courses in his/her own field.
The salary will be on the lower part of the scale £7190-£14 125.
Further particulars may be obtained (quoting reference L 297/C) from the Establishment Office, University House, Bailrigg, Lancaster LA1 4YW, where applications (five copies) naming three referees, should be sent NOT LATER THAN 18 NOVEMBER 1983.

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Life Science Research, winners of the Queen's Award for Export Achievement in 1982, is one of Europe's largest Contract Biomedical Research Laboratories, establishing an outstanding reputation for quality and reliability in the field of safety evaluation. All research programmes are conducted in compliance with Good Laboratory Practice Regulations.

There are three vacancies in the

DEPARTMENT OF CHEMISTRY

We are looking for an Experimental Biochemist to work in a group studying the pharmacokinetics and metabolism of drugs. A good degree and experience with the use of radio-labelled compounds are essential, the latter preferably in drug disposition studies.

Salary range: £6210—£8500

There are also two further positions in the Analytical Control and Biomedical sections, for which a knowledge of chromatographic, spectrophotometric or radiochemical techniques is required. An H.T.E.C. or similar qualification and experience in the pharmaceutical, agrochemical or food industries is desirable.

Salary range: £4500—£7000

Based at Occold in Suffolk, our laboratories are situated in the middle of delightful rural surroundings, half-way between Ipswich and Norwich. Benefits are those you would associate with a major company, including four weeks' holiday a year, rising to five with service, subsidised transport from major population areas, staff pension scheme, an active Sports and Social Club and staff restaurant. Relocation assistance will be given where appropriate.

Please write or telephone for an application form to The Company Personnel Manager, Life Science Research Ltd, Elm Farm Laboratories, Occold, near Eye, Suffolk IP23 7PX Telephone: Occold (037971) 491.

Closing date: Friday 18 November, 1983.

Royal Postgraduate Medical School

(University of London)

Department of Immunology

RESEARCH TECHNICIAN

(Senior Technician)

required to work with Professor J. R. Batchelor on the immunogenicity of passenger cells in rat organ allografts. Applicants should have at least three years experience of broadly based immunological methods, particularly in cellular immunology. Experience in tissue culture and immunochemistry would be an advantage. Applicant should be qualified to degree level (or equivalent). Salary on scale £8266 to £10 599.

Application forms and further particulars available from the Personnel Office, Royal Postgraduate Medical School, 150 Ducane Rd., London W12 0HS, quoting ref 21/101. Closing Date 25 November, 1983.

CRANEDALE CENTRE

FIELD STUDY TUTORS

Tutors are required for March 1984 at the above Field Study Centre in the Yorkshire Wolds. Candidates should possess a good degree or equivalent in the natural sciences and have the ability to teach either/both Ecology and Geography up to "A" level standard. A driving licence is essential and a willingness to undertake weekend, evening and residential duties. Salary £3750 plus free B and L.

The post is initially tenable for nine months. Please apply by letter giving full details of qualifications and experience to Cranedale Centre, Kirby Grindalythe, Nr Malton, North Yorkshire YO17 8DB. Closing date 30 November.

British Telecom University Bursary Awards 1984

If you've the right 'A' levels, we'll sponsor you for an Engineering Degree

We are offering a number of sponsored places on 4 year degree courses, leading to a B.Eng., at the following three universities:

Aston · Newcastle · York

We are looking for very high calibre students, who have (or expect to obtain) at least 3 good 'A' levels or equivalent in Maths and Physics, or Maths and an Engineering/ Physical Science subject.

These enhanced courses, commencing Autumn 1984, will include project work in British Telecom establishments during vacations, for which you will be paid.

And after your Degree? It is hoped that you would begin a management career within British Telecom.

For full details of this Bursary scheme and an application form (to be returned by 25 November 1983), please telephone Miss Lorraine Lampkin on FREEFONE 2237. Or write to her, quoting ref. BAS 84/NS at British Telecom, Inland Division Personnel (STU), Room 1119, 151 Gower Street, London WC1E 6BA.

British TELECOM

HOUGHTON POULTRY RESEARCH STATION

A Grant-Aided Institute of the Agricultural Research Council

HEAD OF THE DEPARTMENT OF MICROBIOLGY

The Governing Body of Houghton Poultry Research Station seeks Applicants for the Headship of the Department of Microbiology which becomes vacant in May, 1984 on the ratiral of Dr H. Williams, FRS.

The Departmant is responsibla for the study of viruses (other than retroviruses) and bacteria important as causes of diseases of poultry. The Department's major current interests include: salmonalla infections important in food poisoning in man; properties of *Escherichia coli* important in the production of disease with or without essocieted virus infection; a study of infectious bronchitis virus with the objective of producing more effective vaccines by using recombinant DNA techniques; Marek's disease viruses with the objectiva of dafining the ganas responsibla for immunoganicity and oncoganicity.

The Heed of the Department will be expected to stimulate, coordinate and leed the research of the Department and to be personally active in research. The post requires managarial ability.

Applicents should have high scientific qualifications and preferably a vaterinary qualification. They should have a proven rasearch record in the fiald of virology or bacteriology with an understanding of molecular biology and preferably experienca in relevant techniques.

Tha appointment will be made to the Senior Principal Sciantific Officar grada (£15 605 x 5 to £19 317). The starting salary will depend on the expenence of the successful candidate.

Further particulars should be obtained from the Station Secratary, Houghton Poultry Research Station, Houghton, Huntingdon, Cambs PE17 2DA. Tel: 0480-64101 and written applications, accompanied by a curriculum vitas, should be sant to the Director to arrive by 25 Novambar, 1983.

LOANS

BRIDGING LOANS
£5000 upwards. Before contracts are exchanged. Apply for brochure and terms. United Provident, 31 Dover St, London W1A 4RT. Tel: 01-499 5416.

FELLOWSHIPS, GRANTS & SCHOLARSHIPS

THE UNIVERSITY OF MANCHESTER
H. WRIGHT BAKER FELLOWSHIP IN MECHANICAL ENGINEERING

Applications are invited for the above Fellowship to be held in the Department of Engineering, Faculty of Science for a period of two calendar years commencing as soon as possible. This is a full-time research fellowship and the Fellow will be remunerated according to agreed national scales within the range £6310 to £8530 (minimum salary for a holder of a PhD degree on appointment £7190); he will also be required to join the Universities' Superannuation Scheme (USS).

The Fellowship was established in 1975 under the terms of a bequest to endow research in Mechanical Engineering by the late Dr Isabel C. Cookson in memorial of Professor Henry Wright Baker.

The level of the award will be determined according to the Fellow's age, experience and qualifications. It is hoped that the successful Fellow will already hold a PhD, but applications will be considered from candidates following a PhD programme on which substantial progress has been made. Details of current researches are available on application from the Department.

Application forms may be obtained from the Registrar, The University, Manchester M13 9PL, to whom applications must be sent by 21 December, 1983.

CHRIST'S COLLEGE, CAMBRIDGE
AMERSHAM SENIOR RESEARCH FELLOWSHIP IN BIOCHEMISTRY

A new Senior Research Fellowship has been founded by Amersham International plc, and applications for the first Fellowship are invited.

The stipend offered is incremental within the range of the University Lecturers' scale (£9875–£15 085), the starting point depending on age and experience; for an unmarried Fellow, accommodation in College may be available, with some adjustment in stipend. The Fellow would be entitled to seven free meals per week (either lunch or dinner) and a Commons Allowance. The Fellowship is intended for a biochemist of exceptional ability who is well qualified for an academic, industrial, or research career, but who does not hold a tenured post at the time of application; it is also suitable for someone on leave from a tenured post who wishes to concentrate on research for a period. It is hoped that the successful candidate, who would normally not be aged above 40, would take up the Fellowship not later than 1 October, 1984 and would hold it for a maximum of four years. Although the choice of a research topic would be left to the candidate, preference will be given to candidates who wish to carry out research involving radioactivity labelled compounds, or applications technology. Candidates will normally be expected to work within the University Department of Biochemistry.

Forms of application may be obtained from Professor Sir Hans Kornberg, FRS, The Master, Christ's College, Cambridge CB2 3BU, to whom completed applications should be returned by Monday, 16 January, 1984.

EDINBURGH UNIVERSITY
POSTDOCTORAL FELLOWSHIP

Spin Dependent Effects in Low Energy Electron Atom Collisions

Applications are invited for a post of two to three years duration, supported by the SERC, from experimental physicists with experience in electron atom scattering. The successful applicant will be involved in a sequence of studies of spin dependent effects in the scattering of low energy electrons by atoms, making use of an existing source of polarised electrons.

Salary on the RG1A Scale

Enquiries and applications with the names of two referees to
Dr O M Campbell, Department of Physics, University of Edinburgh, James Clerk Maxwell Building, The King's Buildings, Mayfield Road, Edinburgh EH9 3JZ

Please quote Reference No 5129

STUDENTSHIPS

UNIVERSITY OF BIRMINGHAM
Department of Physics
POSTGRADUATE SERC STUDENTSHIP

Applications are invited for this SERC studentship in Nuclear Structure Physics, tenable for a period of three years if taken up before January 1984. The studentship is linked to a programme of experiments using heavy ions from the NSF 30 MV tandem accelerator at Daresbury Laboratory, Cheshire. Under the conditions of an SERC award candidates should have a I or IIi Honours Degree in Physics.

Further particulars from Professor G. C. Morrison, Department of Physics, University of Birmingham, Birmingham B15 2TT, to whom applications including full curriculum vitae and naming two referees should be sent as soon as possible.

BRUNEL UNIVERSITY

RESEARCH STUDENTSHIP IN CHEMISTRY

Applications are invited for a studentship for research into the decomposition and the kinetics of decomposition of zinc dialkyl dithiophosphates in hydrocarbon solvents. The work, which is related to the performance of hydrocarbon-based lubricating oils, will also involve thermal analysis, chromatography, and infrared spectroscopy, and will be financed for a period of three years by the Ministry of Defence. Applicants, who should possess a good Honours degree in Chemistry, will register for the degree of PhD. Further details may be obtained from Dr D. N. Waters, Department of Chemistry, Brunel University, Uxbridge, Middlesex UB8 3PH.

UNIVERSITY OF ABERDEEN

Department of Chemistry, Meston Walk, Old Aberdeen AB9 2UE

CASE STUDENTSHIP IN PHYSICAL CHEMISTRY

It is hoped to make an immediate appointment for a SERC CASE studentship under the supervision of Dr L. Batt in collaboration with Shell Research Ltd. The project is concerned with a thermochemical kinetic study of alkyl hydro peroxides in relation to the combustion of hydrocarbons. Applications, including the names of two referees should be sent to Dr L. Batt, from whom further information can be obtained.

UNIVERSITY OF BATH

School of Electrical Engineering

RESEARCH STUDENTSHIP

Applications are invited for a research studentship tenable for 3 years, in the School of Electrical Engineering. The School is engaged in a long term programme of fundamental and applied research in components for microwave and millimetre wave circuits. Good computation, fabrication and testing facilities are available.

Applicants should hold a good honours degree or MSc in Electrical Engineering, Physics or Mathematics to read for a PhD in the area of microstrip circuits. Applications with cv and the names of two referees should be forwarded to Professor T E Rozzi, School of Electrical Engineering, University of Bath, Claverton Down, Bath BA2 7AY.

LECTURES, MEETINGS AND COURSES

BIRKBECK COLLEGE (University of London)

EVENING COURSE IN RECENT ADVANCES IN STRUCTURAL MOLECULAR BIOLOGY

A discussion of recent developments in the study of the structure and supramolecular organisation of the cell cytoskeleton, muscle, chromatin, ribosomes, membrane receptor systems, immunoglobulins and viruses.

The course will be held on Tuesday and Thursday evenings from 6-9 pm in the eleven weeks beginning on 10 January, 1984. It is suitable for graduates in Chemistry, the Biological Sciences, or those with equivalent technical experience. Instruction will be by lectures and practical demonstration, using a large selection of models and modern experimental techniques. Satisfactory completion of the course will be noted by the award of a certificate.

For further information, please apply to: Professor T. L. Blundell, Laboratory of Molecular Biology, Department of Crystallography, Birkbeck College, Malet Street, London WC1E 7HX. Tel 01-580 6622, Ext 284.

UNIVERSITY OF SOUTHAMPTON

M.Sc/Diplome in Insect Control (Research Methods)

"This one year course is open to graduates in Biology, Chemistry, Biochemistry, Agriculture or related subjects. It provides instruction in up-to-date techniques and research methods used in insect pest control. The course is particularly suitable for Biology or Chemistry graduates who wish to become proficient in relevant aspects of both subjects, including the biological basis and development of pest management systems and chemical aspects of control, including pheromones and natural products."

Further information may be obtained from Dr P. C. Jepson, Dept. of Biology, Building 3, The University, Southampton SO9 5NH.

A ONE-DAY COURSE

OCCUPATIONAL AND ENVIRONMENTAL EXPOSURE TO LEAD

16 November, 1983 at the Goldsmith Lecture Theatre, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT. Aimed at all responsible for health and safety in the environment and the workplace. Course fee: £28.50. Programme and registration form from Dr A. Salmon, Short Courses Director, 01-580 2386.

UNIVERSITY OF SOUTHAMPTON

M.Sc. in Tropical and Sub-Tropical Crops Research

Applications are invited for this one year postgraduate course which aims to give qualified scientists engaged in or co-ordinating research on tropical or sub-tropical crops a greater understanding of the various specialist research disciplines involved. This will enable them to understand more fully the nature of their agricultural problems, to define them effectively and to devise efficient research strategies to overcome them. Newly qualified graduates would also benefit from this course before embarking upon a research programme.

Further information may be obtained from Dr P. K. Evans, Dept. of Biology, Building 44, University of Southampton, Southampton SO9 5NH.

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GERMAN-ENGLISH TRANSLATIONS Quick and reasonable, Eckstein, 133 Dorset Road, Bexhill, E. Sussex.

PERSONAL

LOANS FROM £100-£500 to postgraduate scientists for research or other purposes. Salaried Staff London Loan Co Ltd, 175 Regent Street, London W1. For written quote reply 01-734 1795.

SCIENCE AT BATH

BATH COLLEGE OF HIGHER EDUCATION
(incorporating Bath Academy of Art)

BEd RURAL SCIENCE

The three-year Ordinary or four-year Honours courses are for intending teachers in *Secondary Schools*, and place emphasis on the study of managed ecosystems, particularly those involved in crop and livestock production. They offer opportunities for practical study of farm animals and agricultural and horticultural crops.

The courses have particular appeal to those who have a scientific interest in the countryside and who wish to continue biological studies in an applied field.

BEd RURAL SCIENCE AND BIOLOGY

Students take Ordinary or Honours courses which focus either on *Rural Science* or on *Biology* as part of a degree for intending teachers in Primary and Middle Schools.

BA (HONOURS) COMBINED STUDIES

Environmental Biology can be combined with either Geography or History with interdisciplinary studies in areas of common interest.

Enquiries and applications:

The Registrar
Bath College of Higher Education
Newton Park
Bath
BA2 9BN
Tel: Saltford (02217) 3701

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ARIADNE

THE ONLY time I have seen the fish called John Dory was on a fishmonger's slab in Sloane Street. Its hideous face stared out of surrounding designs made of herring, mackerel and other more familiar seafood. It was more of a presence than a fish, and I doubt whether many people bought a slice of it. It looked as if it would have had something to say about it when night fell, capable of conjuring up the forces of Satan.

The only time I have met the fish called pollock or pollack or, I'm told, rock salmon (except in a batter overcoat), was when I was suborned to deliver a catch to a ghillie in Cape Wrath. He showed a lack of enthusiasm that chimed with mine.

But, of course, ignorance and deliberate disguise, make all the difference. I now learn, for instance, that I have been eating Alaska pollack, cut into strips and dyed crab-pink on one side to give the appearance of leg meat from king crab. I knew I could not possibly be eating crab meat at the price and in that quantity, but it was enough that it tasted a bit like crab and looked a bit like crab.

In the books I read when a child, there were, sometimes, cannibals and cannibals who talked happily enough about the infrequent real feasts with real people on the menu. But even they, I now realise, went for food psychology as well as protein. They called the meat "long pig".

I have heard about people being unable to eat the rabbits they have kept, or the ducks. I can understand this and more. Once I was served pork from a pig that I had no emotional ties with. All I knew was that it had been alive on the particular farm the week before. I had seen it in its sty. It was mad, tirelessly running round and banging its head on the walls. I cannot find a rational explanation for refusing the meat from a lunatic pig. The vegetables were all right. □

SOMEHOW I missed the news of the latest Californian surgical implant. It is a hydraulically operated penile prosthesis. It has a miniature pump which allows erection to be maintained until a button is pushed, when collapse of stout party follows and things or thing get back to normal.

All this is amazing enough, but it was not the wonders of hydraulics that interested me. It was the money involved. Dr. Gary Alter, who practises in Los Angeles, carries out around 60 implants a year. Each costs £12 000. Nearly three quarters of a million pounds for one surgeon, from one type of operation, in one year. It is hardly astonishing that the number of implants is, if you will pardon the phrase, rapidly rising. □

THOSE WHO ride motor cycles are, as we all know, equalled in virtue only by those who ride cycles. So what I am about to draw attention to applies only to those foreigners and aliens from other worlds who ride motor cycles in an effort to ruin the reputations of the natives.

Some motor cycles make an appalling noise, and they appear to be just those

machines that are continually revved up by their riders while traffic is halted. There is, I think, some myth that making a din is, like getting drunk on beer, somehow a tough, masculine and impressive activity.

Information from the British Standards Institution says that the deafening racket is caused by sub-standard exhaust systems. It then adds that much of the trouble is caused by replacement systems, "since these are not subject to the noise controls that apply to the whole machine when new".

The BSI remarks that the government intends to close this loophole. Good news, that, and let us hope that the Minister of Transport, whoever he is (we have had three in quick succession recently) will get a move on. What bright framer of Parliamentary Bills missed the loophole, I wonder. I assume that, on the rare and possibly unique occasion when a visitor from outer space was stopped by the police for splitting the ears of innocent bystanders, he gave his alias without showing his pointed ears concealed in the crash helmet and explained he was using a replacement system, guv. "My hands are tied, then, because of the loophole and you are free to rev off," the constable would have replied. □

SOONER or later, the watchmakers will have to come to terms with our ageing population. I have a watch that, once the button-pushing has been mastered, will sound off an alarm. Useful, said the advertising, for telling you when the time is up on the parking meter, or reminding you of an appointment or even for getting you up in the morning.

But the watch is soundless to me. I have reach the age when high frequencies are becoming inaudible. Already I have to provide the highest notes of the violin in the Beethoven concerto from memory. So I took the watch back and asked for another model. The assistant sounded the alarm. Everyone else in the shop made for the door, or started to look about in a hunted fashion. I kept saying, "Well, get it going then. Come on, I haven't got all day. Do you want to sell me a watch or don't you?" and similarly endearing sentences. Finally, I crept out with the original watch.

By the end of the century half the people in the world will be over 60 or some such figure. They will all be late for appointments, oversleeping and getting fined for parking. How about bringing the frequencies down to the audible range for the geriatrics? □

AGRICULTURE, says Daedalus, uses sunlight to react carbon dioxide and water, producing oxygen and plant biomass. He is seeking the simplest way of doing this, with the absolute minimum of human effort. He recalls that many microporous polymer films are quite permeable to gases, but impermeable to liquid water, bacteria, etc. So he is inventing a totally enclosed silicone-film greenhouse.

The plants in the new greenhouse have a fairly basic soil containing the minor nutrients (nitrogen, potassium, etc) and are simply left to get on with it. As they grow, the carbon dioxide and water vapour they use up will be replaced by diffusion through the silicone film, but pests, disease bacteria, alien seeds, etc, cannot enter. Daedalus is devising subtle ecological mixes of small, fast-growing, complementary plants, together with selected rot-fungi to recycle dying matter, and maybe one or two beneficial species of insect. The ideal mix should grow as rapidly as possible to the maximum biomass. It should then continue in stable cyclic equilibrium like a tropical rain forest until harvesting becomes convenient—preferably by simple pulverisation to some sort of basic edible plant-flour.

As a final, brilliant stroke, Daedalus will put the whole thing out to sea. His marine greenhouses, constructed like enormous, squat, flexible polymer-film air-mattresses, will wallow freely in the waves. The cold sea will condense excess internal humidity back to liquid water, both keeping the greenhouse soil damp and permitting free transpiration from the plant leaves. Like Kon-Tiki rafts, marine greenhouses will be seeded and launched into the main ocean currents, and reclaimed a few weeks or months later at their destination, ready for harvesting. Deflated and rolled up, they would then be returned by cargo ship to repeat the cycle. Gulf-stream greenhouses, launched into the Gulf of Mexico for capture off Ireland or France, could replace the present transatlantic grain traffic at almost negligible cost. □

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